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Energía de
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Vehículos eléctricos y
el impacto en el sistema
de potencia.

Explotación de los
campos shale gas
en México.

Escenarios energéticos
para la extracción de
petróleo en la amazonía
ecuatoriana.

Comparación del algoritmo
de retroceso en sistemas
fotovoltaicos en Honduras.

China's footprint in Brazil's
electricity sector.

Las implicancias jurídicas de
la naturaleza jurídica de la
energía eléctrica en la
legislación peruana.

Diseño de una estación de
carga solar para vehículos
eléctricos en centros
comerciales.

Estimación del efecto escala
de la generación eólica en la
Argentina.

Potencialidad para la
implementación de
comunidades energéticas
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CHINA'S FOOTPRINT IN BRAZIL'S ELECTRICITY SECTOR: EVOLUTION AND FEATURES

*LA HUELLA DE CHINA EN EL SECTOR ELÉCTRICO DE BRASIL:
EVOLUCIÓN Y CARACTERÍSTICAS*

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ABSTRACT

This article aims at analyzing China's penetration in Brazil's electric sector in each of its three segments and different sources of energy. It offers the first estimates of Chinese-controlled power generation installed capacity, kilometers of transmission lines, and number of consumers in Brazil, and their evolution over time based on Brazilian official data. In ten years, Chinese electric power companies have become the main foreign investors, and Brazil concentrates the biggest part of these corporations' overseas power generation capacity. Chinese firms' investment pattern there is different from other countries, where they focus on non-renewables. Instead, in Brazil they have invested where the country has a natural advantage or an abundance of resources, such as hydroelectric generation.

Keywords: Foreign Direct Investment, Electric Power Sector, Transmission, Distribution, Brazil, China.

RESUMEN

El objetivo de este artículo es analizar la penetración de China en el sector eléctrico del Brasil en cada uno de sus tres segmentos y en sus diferentes fuentes de energía. Ofrece las primeras estimaciones de la capacidad instalada de generación de energía controlada por China, kilómetros de líneas de transmisión, número de consumidores en el país y su evolución en el tiempo basado en datos oficiales brasileños. En diez años, las compañías eléctricas chinas se han convertido en los principales inversionistas extranjeros y Brasil concentra la mayor parte de la capacidad de generación de energía en el extranjero de estas corporaciones. El patrón de inversión de las empresas chinas en Brasil es diferente que en otros países, donde se centran en energías no renovables. En cambio, en Brasil han invertido donde el país tiene una ventaja natural o abundancia de recursos, como la generación hidroeléctrica.

Palabras clave: *Inversión Extranjera Directa, Sector Eléctrico, Transmisión, Distribución, Brasil, China.*



Brazil's electricity sector has been undergoing a continuous internationalization process over the last two decades, with foreign players speeding up investments in the country.

INTRODUCTION

Brazil's electricity sector has been undergoing a continuous internationalization process over the last two decades, with foreign players speeding up investments in the country. Since 2010, this phenomenon has gained vigor with the arrival of a new player: China. After ten years, by a combination of mergers and acquisitions (M&A) and greenfield foreign direct investments (GFDI), Chinese presence in the Brazilian electricity sector has expanded considerably. As of 2019, Chinese electric power companies became the leading foreign players in the country, owning roughly 10% of Brazil's generation segment, 12% of transmission, and 12% of distribution. Besides, they ranked the second, third, and fourth places in terms of nationalities' percentage of these sectors respectively.

Reasons for Chinese interest in Brazil abound: Brazil's still vast power generation potential (BloombergNEF, 2020), relative saturation of the Chinese domestic market for big-scale infrastructure projects, business opportunities brought by the country's economic crisis and corruption scandals since 2014, currency depreciation, legal changes that triggered disruptions in the electricity sector (Becard, Lessa, and Silveira, 2020), and governmental incentives, such as a stable regulatory frame in the energy sector (Rosito, 2020) are among the main motives.

Not only China became relevant to Brazil's electricity sector, but the South American country had an important role in Chinese companies' global push. Over the last two decades and particularly after the 2008 worldwide financial crisis, Chinese electricity companies went on an international spree that reached nearly every continent (Ma, Gallagher, and Guo, 2019; Cabré, Gallagher, and Li, 2018). Since 2010, Brazil was one of the main destinations of Chinese electric power firms (Gopal, et al., 2018; Li, Gallagher, and Mauzerall, 2018). After ten years,

it concentrates the biggest part of these corporations' overseas power generation capacity. Some of these, such as State Grid and China Three Gorges (CTG), have the majority of their external assets in Brazil (Gallagher, Li, Chen, and Ma, 2019).

Concomitant with the increasing number of Chinese electricity investments in Brazil, an upsurge of academic publications and media reports about this phenomenon has followed suit.¹ The recent growth of studies notwithstanding, the actual extent and the evolution over time of China's penetration in the country's electric sector in each of its segments and sources of energy and the role of Brazil in these companies' overseas expansion are not yet well known.

This article aims at analyzing the extension, some reasons, and the characteristics of Chinese power companies' assets in Brazil's electricity sector and the importance of the South American country in these firms' overseas investment plans. Relying on primary sources – official data from the National Electricity Regulatory Agency (Aneel) –, it provides the first estimates of Chinese-controlled power generation ins-

1 Leite and Vanderlei (2017), Cote (2014), Cui and Zheng (2019), Hiratuka (2018), Vanderlei (2018), Barbosa, Tepassê and Biancalana (2014), and Proença and Kupfer (2018) study State Grid's activities. Hochstetler and Kostka (2015) and Cuperstein (2014) examine the wind and solar sectors. Xu (2019) analyzes the bilateral cooperation in renewables. Cavalcante (2018) focuses on solar energy. Silveira (2018) assesses the Chinese state-owned energy enterprises investments in Brazil and their strategic interest in the Amazon. Tang (2017), Da Silva (2019), Becard and Macedo (2014), Ferreira, Santos and Neves (2019), and Schutte and Debone (2017) write about Chinese investments in the electric sector as a whole. Husar and Best (2013) discuss the possibility of bilateral technology cooperation. Becard, Lessa and Silveira (2020) emphasize the political and economic impacts of Chinese investments.

talled capacity, kilometers of transmission lines, and number of consumers in Brazil, their evolution over time, and their percentage of the whole local system. It argues that Chinese companies have adopted a distinct investment pattern there, investing predominantly in renewable energy, in contrast to the dominant coal portfolio of China's overseas power electric projects. It concludes that the case of Brazil illustrates that Chinese players focus their energy investments where the host country has a natural advantage or an abundance of resources.

METHODOLOGY

This work has resorted exclusively to primary resources to research Chinese power generation, transmission, and distribution assets in Brazil: official documents and databases from the National Electricity Regulatory Agency's (Aneel) as of May 2020.

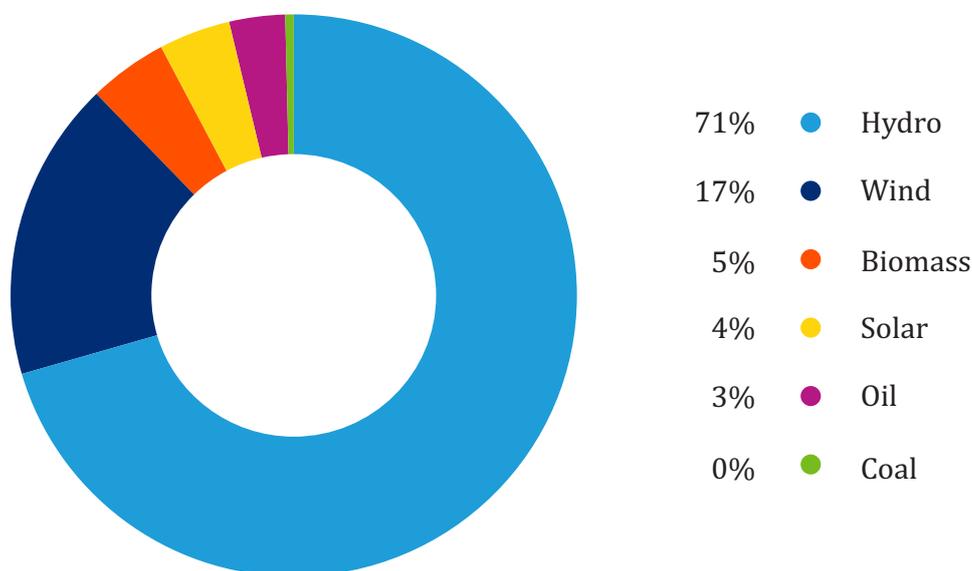
The total of MW attributed to each Chinese company in this article reflects the firm's participation in the consortium or concessionaire, whose ownership structure is provided by Aneel (Aneel, Participacao Acionaria dos Proprietarios dos Empreendimentos, 2020). The same logic is applied for Chinese corporations in the distribution segment. In the transmission part, the kilometers of lines that are attributed to Chinese actors are not calculated according to the company's share of the consortium. If the Chinese player has the controlling stake of the investment group, the total line is considered Chinese.

For the sake of identifying the nationalities behind each concessionaire, the following information was checked in Aneel's reports: investing companies in the concessionaire, their nationality/origin, ownership percentage of the plant and installed capacity. The nationality of each investing company is determined according to the address registered at Aneel.

POWER GENERATION

Over the years, Chinese electric power firms progressively expanded the percentage of Brazil's electricity installed capacity under their control. In the end of 2019, Chinese companies owned or partially owned 304 power plants, which totaled 16,736 MW.² This is close to 10% of the national system, which ended 2019 with 170 GW (ONS, 2020a).

Figure 1. Chinese companies' installed capacity per source of energy (GW, 2019)



Source: Aneel, 2020a

Figure 1 shows that, in terms of technology mix, 70% of Chinese electricity capacity in 2019 is in hydropower (11,798 MW). Wind power took up 17% (2,888 MW), and biomass, solar, oil, and coal comprised 5% (759 MW), 4% (680 MW), 3% (532 MW), and 1% (79 MW), respectively (Aneel, 2020a). This distribution reflects the pattern of Chinese foreign direct investments (FDI) in Brazil, which is concentrated in hydro and wind plants (Barbosa P., 2020).

Putting Brazil's electricity matrix and Chinese local electric assets in perspective, there are resemblances and differences. Primarily, the latter is similar to the Brazilian overall installed capacity, 64.9% of which was based on hydropower in 2019. Additionally, both matrixes are based on renewable energy, with the distinction that the Chinese one (97%) is even cleaner than the national structure (83.4%) (EPE, 2020b). Distinctions are: 25% of the

² The total of MW attributed to each Chinese company here reflects this firm's share in the consortium or concessionaire.

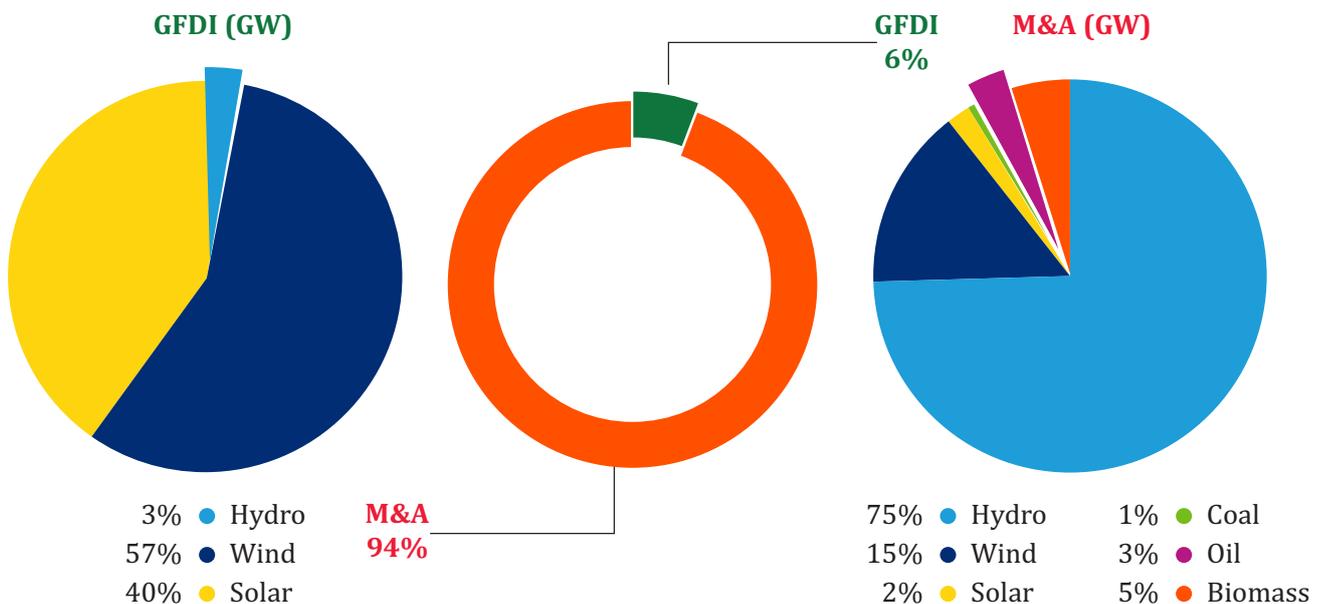
national capacity comes from thermoelectric plants, whereas the Chinese percentage in Brazil is 9%; Chinese actors invested more in solar and wind (21%), whilst Brazil's total capacity is roughly 10%; there are no Chinese investments in nuclear power, which is 2.6% of the national matrix (EPE, 2020a).

Chinese electricity assets in Brazil diverge from its own national matrix, of which 27% is based on renewables in 2019 (BP, 2020). Moreover, comparing China's investments in Brazil with those in other nations, new differences emerge. Resorting to data from Boston University's GDPC, most of Chinese overseas installed capacity is on coal power (42%), followed by hydro (26%), gas (15%), wind (6%), nuclear (5%), solar (4%),

and oil (2%). Biomass and geothermal figures are minimal (Gallagher, 2019). Therefore, 36% of the country's foreign power generation came from renewables. The case of Brazil illustrates that Chinese players focus their energy investments where the host country has a natural advantage or an abundance of resources.

Of the total Chinese installed capacity in Brazil, the absolute majority was acquired through acquisitions (94%). Interestingly, analyzing separately each type of investment, it becomes clear that while brownfield investments targeted all sources of electricity, with a prominence on hydropower and wind (Aneel, 2020a), GFDI almost exclusively went to wind and solar generation (Aneel, 2020b) (figure 2).

Figure 2. Chinese installed capacity in Brazil per technology (GW) and mode of entry



Source: Aneel, 2020a; Aneel, 2020b

Focusing on spatial distribution, the Chinese owned 304 power plants are dispersed in 17 states and are present in all five regions of the country. The Northeast concentrated the majority of plants (160), and the Southeast, the highest capacity (10 GW). Individually speaking, the Northeastern state of *Rio Grande do Norte*

(RN) has the top number of plants (79), and the Southeastern Sao Paulo (SP), the biggest generation capacity (7.9 GW). The Southern states rank third, with 55 units and 2.2 GW, followed by the North with five dams and 0.7 GW, and the Center-West with three dams and 1.4 GW (Aneel, 2020c).

If one considers the short time since Chinese firms arrived in Brazil's power generation sector, the fast pace of their expansion is remarkable. After some years of low increase of installed capacity, numbers have grown exponentially after 2015 – when CTG bought Ilha Solteira and Jupia dams –, reaching 6.7 GW at the end of the year. Total Chinese-installed capacity jumped to 14.7 GW in 2017 – with State Grid's acquisition of *Companhia Paulista de Força e Luz* (CPFL) – and to 16.7 GW in 2019 (Aneel, 2020a; Aneel, 2020b).

The first Chinese firm to enter Brazil's power generation sector is CTG, with the purchase of Energias de Portugal (EDP) in 2011, guaranteeing therefore an indirect participation in EDP Brasil and EDP Renovaveis (EDPR), which were already well established in the Brazilian energy market, with stakes in transmission and distribution as well. Over the following years, CTG has consistently invested in other projects in the country. China-Latin America Investment Fund (CLAI Fund) and the China National Cereals, Oils and Foodstuffs Corporation (COFCO) followed suit in 2015 and were joined by State Grid, State Power Investment Corporation (SPIC), Zhejiang Energy, China-Latin American Cooperation Fund (CLAC Fund), China-Portuguese Speaking Countries Fund (CPSC Fund), and Canadian Solar in 2017. Jiangsu Communication Clean Energy Technology (CCETC) and China General Nuclear Power Corporation (CGN) arrived in Brazil, in 2019 (Aneel, 2020a; Aneel, 2020b).

On the company level, figure 3 demonstrates that CTG is the one that accumulated more generation capacity over the years (6.5 GW in 85 plants) and has Brazil's second largest installed capacity (Aneel, 2020c). It is present in 12 states, but has the majority of its stakes in SP (16), Santa Catarina (SC, 18), and RN (37). Its energy technology matrix is also diversified. It is mainly based on hydraulics notwithstanding, the company invested also in wind – alone and through EDPR as well –, solar, and coal power.

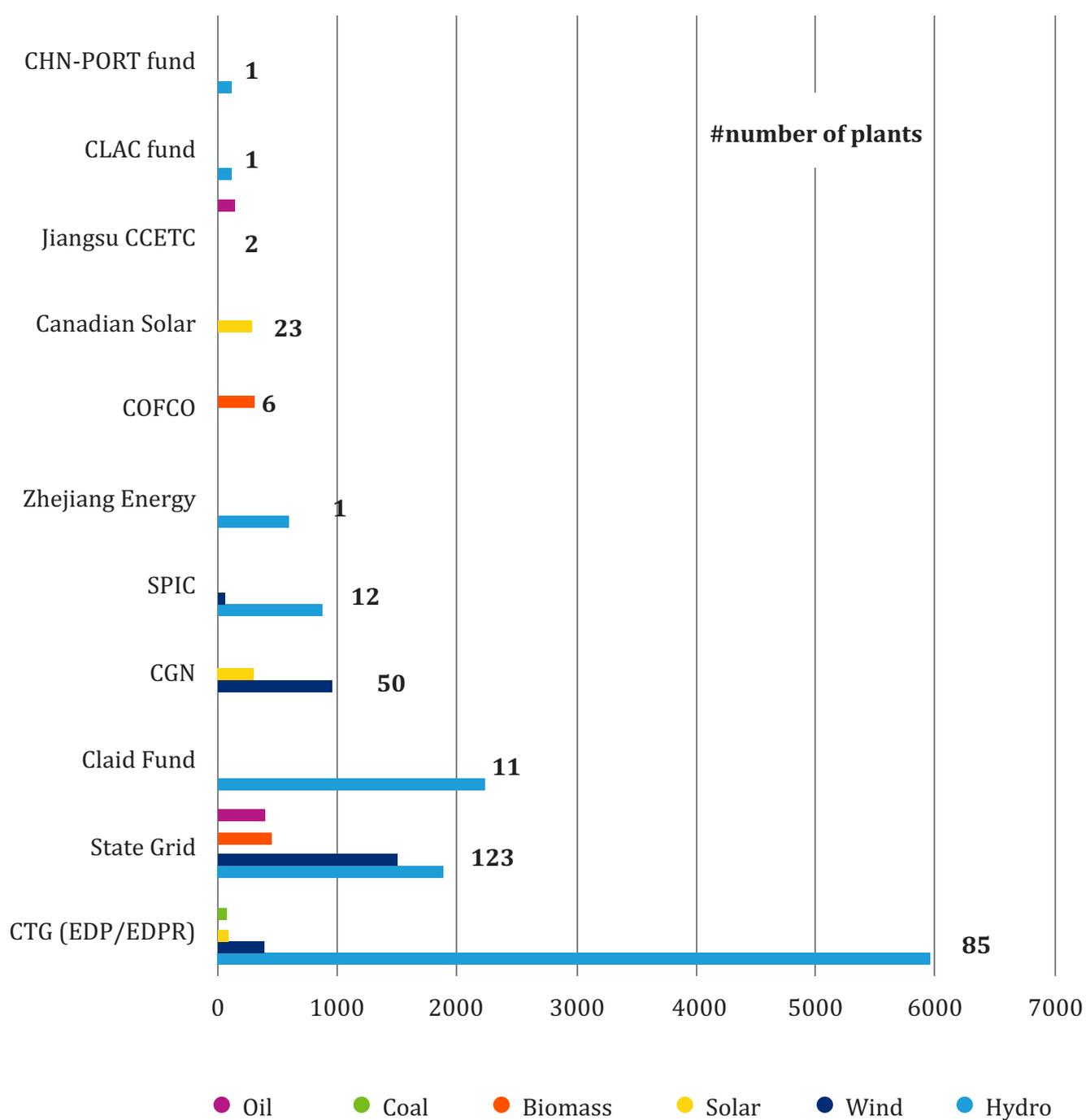
State Grid has 4.3 GW scattered among 123 units in 10 states. All this capacity belongs to CPFL. This firm is the third biggest private agent in Brazil's generation sector – and the ninth in total (Aneel, 2020c). Its acquisition in 2017 is the single biggest transaction by a Chinese energy firm and a strategic and milestone move of State Grid in Brazil.

The reason for CPFL having more units than CTG, but less capacity, is because it has a more diversified portfolio. CPFL's own hydro power capacity do not reach half of its total, with the rest divided among wind, biomass, oil, and very little solar power. The majority of CPFL's plants are in SP (35) and RN (37).



Foto de Pixabay.

Figure 3. Installed capacity per source (MW) and number of plants³



Source: Aneel, 2020a

³ The number of plants refers to the units where each company have stakes; in some plants, more than one Chinese company have shares.

Huikai Clean Energy, which is controlled by the CLAI Fund, has a total of 2.2 GW in 11 hydro-power dams in SP (9), Parana (PR, 1), and Mato Grosso do Sul (MS, 1), always in partnership with CTG, which directly operates the plants. Other Chinese investment funds active in Brazil are the CLAC Fund (120 MW) and the CPSF (120 MW). Like Zhejiang Energy (599 MW), they have joined SPIC to acquire the Sao Simao dam (in Minas Gerais - MG), their sole possession in Brazil. SPIC operates the project. By contrast, SPIC has other 11 units in Paraiba (PB) and 930 MW in total.

Distinctively, CGN has no hydroelectric dams and has invested only in wind and solar generation. It owns 50 plants that total 1.3 GW of capacity in the states of Rio Grande do Sul (RS, 12), Bahia (BA, 20), Piaui (PI, 16), and RN (2).

Canadian Solar is the only non-state-owned enterprise (SOE) that has generation assets in Brazil (23 plants).⁴ Consequently, 98% of the Chinese projects in the country belongs to firms indirectly managed by central and provincial branches of the State-owned Assets Supervision and Administration Commission of the State Council (SASAC). Chinese SOE, in fact, are the chief investors in the overseas electric market, which is a unique feature of Chinese investments *vis-a-vis* most Western players (Gallagher, Kamal, Jin, Chen, and Ma, 2018).

4 State Grid, CTG, CGN, and SPIC are central SOE, directly supervised by SASAC. Zhejiang Energy Brazil belongs mostly to Zhejiang Province's SASAC. CCTEC Brazil belongs to the provincial government of Jiangsu. Canadian Solar was founded in Canada, but has the majority of its manufacturing presence in China.



Foto de Dan Meyers de Unsplash.

Figure 4. Geographical distribution of Chinese installed capacity per source (MW)

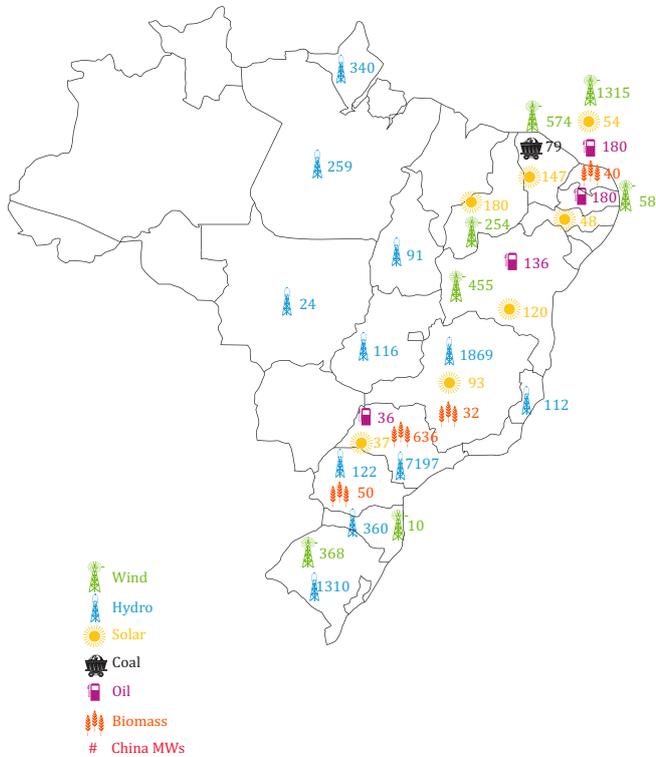
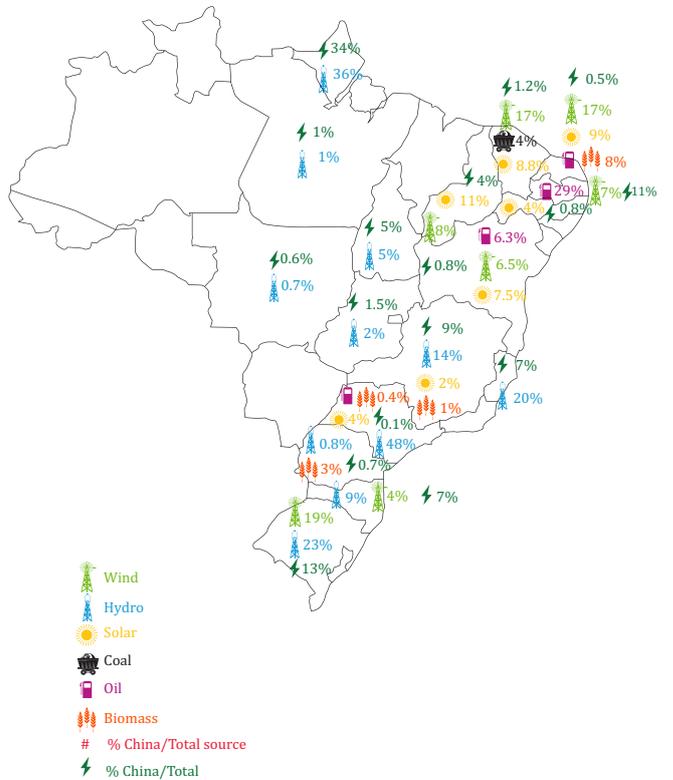


Figure 5. Percentage of Chinese installed capacity per source and state ⁵⁶⁷



Source: Aneel, 2020c; Aneel, 2020e

If one considers the short time since Chinese firms arrived in Brazil's power generation sector, the fast pace of their expansion is remarkable.

5 Aneel does not provide separate data about thermolectrical energy sources, such as coal, oil and biomass in the state level. Therefore, the numbers used for calculation are those of the generation capacity of thermolectrical dams in each state.

6 The data chosen about state's total generation capacity encompasses those related to operational, under construction and construction not initiated, because some Chinese projects are still not operational.

7 Since Aneel does not provide historical data of each state installed capacity per technology, the numbers used are from May 2020.

Analyzing the geographical distribution of installed capacity in terms of technology mix, there are some interesting findings (figure 4). Firstly, hydropower assets are present in all regions, except the Northeast. Besides the Northeast, there are some wind and solar plants in the South (RS and SC) and Southeast (SP and MG), although with smaller numbers. Biomass is mostly concentrated in SP, with one plant in the states of PR, MG, and RN, each. Oil-fueled power plants are mainly in the Northeast, with one facility in SP. Lastly, coal is only present in Ceara (CE). Individually, SP is the state that not only has the biggest installed capacity overall (7,906 MW), but lead as well in hydropower (7,197 MW) and biomass (636 MW). RN has the majority of wind farms, and PI, the most of solar generation (180 MW) (Aneel, 2020c).

Calculating the percentage of how much Chinese players have per source of electricity in each state, other remarkable results are found (figure 5). Firstly, in terms of total electricity capacity, China's participation varies considerably. Some states' electricity production has high contribution from Chinese companies, such as Amapa (AP, 34%), RS (13%) and PB (11%). However, in general, Chinese shares are small (Aneel, 2020c).

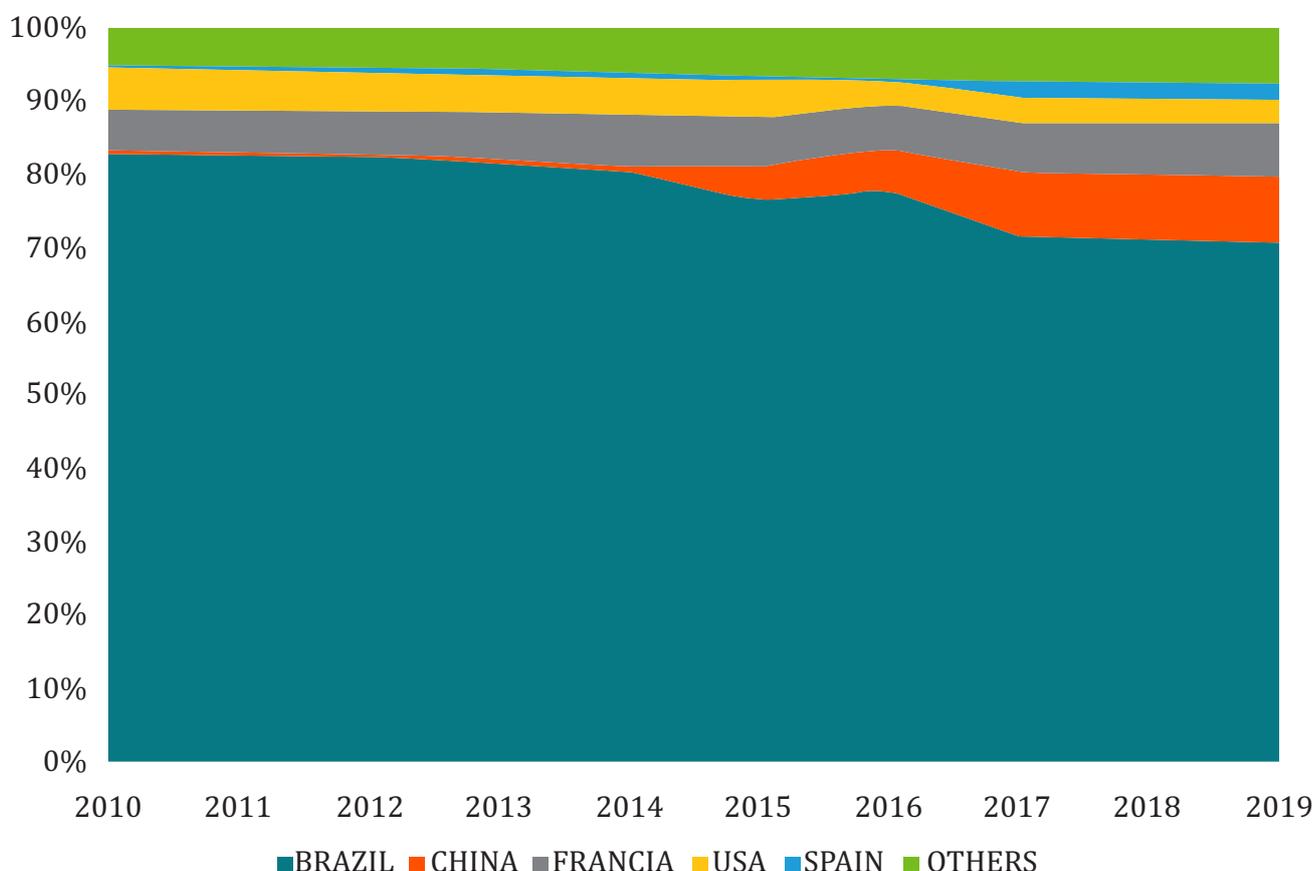
Secondly, in an electricity source analysis, the situation is different. For instance, despite the fact that SP concentrates most of Chinese stakes, China's participation in this state's total installed capacity is minimal (0.1%). However, 48% of the state's hydro generation is in the hands of Chinese actors. Different to other places that rely more on one source of energy, Sao Paulo has a diversified and balanced technology mix. In AP, RS, and Espirito Santo (ES), 36%, 23%, and 20% of the hydropower capacity is administered by Chinese companies, respectively. In wind power generation, Chinese firms possess 19% of RS' capacity and 17% of CE and RN. In solar power, they have 13% in RS and 11% in PI, to name a few.

Positioning Chinese investments in Brazil from a global perspective, one can understand the role and the importance of the country in China's global energy investments. According to data from GDPC, until 2018, at least 63 Chinese energy firms have full or partial asset ownership in up to 186.5 GW of overseas capacity, distributed through 777 plants. Asia by far concentrates most of the Chinese assets, with Latin America coming in a distant second place. Individually, Brazil is the main target, followed by Pakistan, Indonesia, and Vietnam. Out of the ten biggest Chinese companies abroad in terms of installed capacity, only three have assets in Brazil, namely CGN (ranking 1st), CTG (2nd) and State Grid (7th). Some Chinese giant energy firms, such as China Huaneng Corporation (3rd), CLP Holdings (4th), and China Huadian Corporation (6th), have no projects in Brazil (Gallagher, Li, Chen, and Ma, 2019).

Until the end of 2018, CGN accumulated globally a total of 19,740 MW, whereas CTG 16,718 MW, SPIC 9,178 MW, State Grid 7,409 MW, and Canadian Solar 3,167 MW. Comparing these numbers with their assets in Brazil until that year, the South American country represents roughly 6%⁸, 39%, 10%, 57%, and 9% of their overseas possessions respectively.

8 Since CGN's first investment in Brazil was in 2019, for the sake of comparison, we are using these numbers to compare with the company's total assets through 2018.

Figure 6. Nationalities of generation concessionaires in Brazil (MW)



Source: Aneel, 2020a

Comparing Chinese electricity investments in Brazil’s power generation sector with other foreign players’ performance in the country over time, new findings emerge (figure 4). Mapping the changes in the ownership structure of Brazil’s 8,728 power plants in operation in 2019 and tracing back these modifications until 2010, one may see a process of continuous internationalization and diversification of the local generation sector. Over the years, new foreign players from different nationalities have bought assets or started new businesses. Their share of the total installed capacity has progressively increased at the expense of national actors. As of 2019, there were companies from 31 countries active in Brazil (Aneel, 2020a).

Brazilian concessionaires started the period of analysis with 83% of the generation segment,

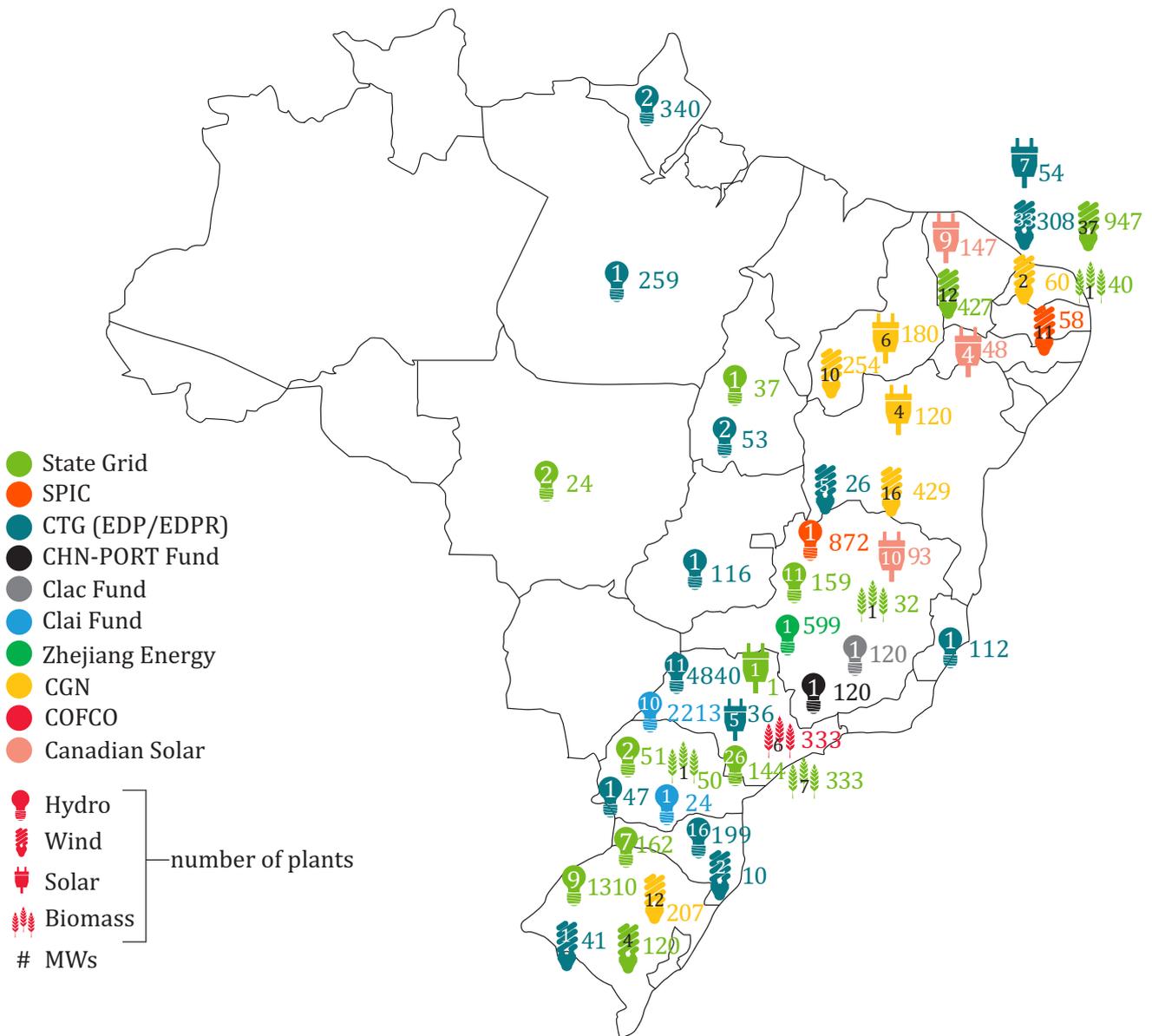
followed by French and North-American, with around 6% each. Over time, this situation has changed, particularly from 2014 on, when Chinese capital started to flow in great quantities. The entrance of Chinese actors has caused big changes in ownership structure, progressively occupying the space from local firms and ending 2019 in the second place. US shares have also decreased over time. French companies have pretty much kept their annual percentage, but in 2017 lost their leading position among foreigners to China. Spanish, Italian, and Canadian corporations’ capacities have grown steadily year by year, especially the former ones, at the expense of Dutch and Luxembourgian. After all these changes, 2019 ended with Brazilian players having 71% of the power generation segment, followed by the Chinese with nearly 10%, and French with 7%.

Chinese investments per source of energy

China's hydropower installed capacity in Brazil is 11.8 GW, or 70% of Chinese firms' total, and is divided in 93 dams, located in 11 states. Only the Northeast region has no Chinese adminis-

tered hydroelectric dams. Comparing to the country's total installed hydropower capacity – operational, under construction, and construction not started –, which ended 2019 with 111 GW, Chinese firms have almost 11% of the national sector.

Figure 7. Geographical distribution of generation installed capacity per company (MW and number of plants)



Source: Aneel, 2020c; Aneel, 2020e⁹

9 As of May 2020, Aneel does not differentiate thermoelectric plants by technology in its generation database (Aneel, Sistema de Informações de Geração da ANEEL, 2020). Therefore, coal-fueled plants are included in biomass here.

CTG is the one with bigger installed capacity (5,965 MW), in 34 dams. 16 are in SC, and most of these (15) belong to Celesc, which is controlled by EDP (Aneel, 2020 c). In contrast, SP (11) has the majority of the generation power (4,840 MW). After EDP's purchase in 2011, CTG has acquired several hydropower dams, assuming the control of some of Brazil's largest units, such as Jupia and Ilha Solteira (both in SP). As a result, CTG became the second major electric generator in Brazil, behind the state-owned Eletrobras (Aneel, 2020c). It has also one dam in the states of PR, ES, Goiás (GO), Tocantins (TO), Para (PA), and AP.

After CTG, CLAI Fund is the one with more installed capacity (2,236 MW). It has participation in 11 dams, one in PR and ten in SP, and all of them in partnership with CTG, which operates them.

State Grid has 1,887 MW in Brazil, all of them part of CPFL's portfolio. This company has a total of 58 dams, in seven states. The majority are in SP (26), mostly small size (known as PCH). Yet, in terms of installed capacity, RS has more MW (9 dams). There are also dams in SC (7), PR (2), MG (11), Mato Grosso (MT), (2), and TO (1). State Grid has been active in the country since 2010, but only in 2017, when it bought CPFL, it entered the generation sector. In 2018, it purchased CPFL's renewable energy arm: CPFL Renovaveis.

SPIC, Zhejiang Energy, CLAC Fund, and CPSC Fund started to invest in Brazil's power generation in 2017, with the acquisition of the Sao Simao dam (MG). SPIC is the operator and has 51% of the barrage, whilst Zhejiang Energy has 35%, and the other two, 7% each.

Chinese wind power capacity in Brazil is 2,888 MW, or 17% of Chinese total installed capacity in the country. Comparing with the national total of 24,854 MW in plants that are in operation, under construction or construction not started in Brazil in 2019, it is roughly 12% of the country's wind generation capacity (Aneel, 2020c).

State Grid, through CPFL Renovaveis, has the most MW installed (1,494 MW) and the majority of wind farms (51), mostly in the Northeastern RN (37) and CE (12), but there are four in the Southern RS. The great majority of the plants were developed before State Grid's acquisition, but CPFL's expansion has continued after, especially through participation in Aneel's bids (Aneel, 2020b). After years of heavy investments in the sector, CPFL became the main single wind power generator in Brazil (Aneel, 2020c).

CGN comes after State Grid in wind power capacity, with roughly 950 MW, in 40 plants. The company is present in four states, namely BA (16), PI (10), RN (2), and RS (12). The firm arrived in Brazil in January 2019 through the acquisition of three farms from the Italian Enel (Enel, 2019).

CTG has 385 MW in 41 projects, either directly or through EDPR. The company is present in four states – RN (3), RS (1), BA (5), and SC (2). EDPR started investing in Brazil's wind sector in 2013 through Aneel's auctions. In May 2015, CTG bought 49% of 11 farms from EDPR. Over the following years, EDPR won several new projects in Aneel's bids.

Lastly, SPIC has 58 MW in 11 farms, all in PB, which belonged to Pacific Hydro Brasil until 2017.

Chinese companies' solar generation capacity is 680 MW in the end of 2019. With the total of 12,929 MW that are in operation, under construction or construction not started in Brazil, it is roughly 5% of the country's total solar power (Aneel, 2020c).

Canadian Solar is the company that invested the most in Brazil. In the end of 2019, it had 23 solar farms with 288 MW, mostly under construction and located in MG (10), CE (9), and Pernambuco (PE, 4). It has been actively participating in Aneel's auctions since 2014. However, over the years, it has done disinvestments, selling a few solar farms to the French EDF and to Nebras, from Qatar (Aneel, 2020a).

CGN has 10 farms with 300 MW in BA and PI. They are all part of three solar parks that CGN bought in 2019 from Enel Green Power. This acquisition led the company to become one of the major solar players in Brazil.

CTG have 12 plants with 90 MW in total. These all belong to EDPR and are located in SP (5) and RN (7). Lastly, State Grid/CPFL Renovaveis have only a small-scale project in SP.

Chinese corporations have 16 biomass plants whose installed capacity is 759 MW as of 2019. Most of them are located in SP. Considering that Brazil's total biomass generation capacity in that year was 15,234 MW, the Chinese share is close to 5% of the whole (Aneel, 2020c).¹⁰

CPFL Renovaveis has 10 plants with a total of 455 MW, most of them in SP (7), but one in MG, PR, and RN. COFCO, in contrast, have six facilities in SP. They were bought from Noble in 2015.

As for Chinese non-renewable energy facilities in Brazil, their percentage is small, only 4% (or 611 MW). There are six plants, using oil and coal to generate electricity. As of end-2019, there were no projects with nuclear energy. CPFL has one oil-based thermoelectric plant in the states of SP, PB, and RN. Jiangsu Communication Clean Energy Technology (CCETC) has two in BA, which were under construction as of end-2019.

Brazil represents only a small fraction of China's overseas coal-based generation investments, which amounted to 79,500 MW in 107 plants, or 42% of the total in 2018 (Gallagher, Li, Chen, and Ma, 2019). The single coal-based Chinese asset in Brazil is Porto de Pecem I, in Ceara, and is owned by EDP.

10 At the time of the data was collected in May 2020, Aneel did not distinguish the thermoelectric plants under construction and construction not started per source – biomass, oil, coal –, so in this part, the comparison is only made with biomass facilities in operation.



TRANSMISSION

The history of Chinese investments in Brazil's transmission sector is entangled with State Grid's individual expansion there. This firm was responsible for the absolute majority of Chinese power companies' investments in the South American country until 2019. Consequently, 87% of the 16,776 km of Chinese-owned transmission lines belong to it. CTG – always through EDP and Celesc – and Zhejiang Insignia United Engineering are other Chinese active players. Their assets altogether account for almost 12% of the total length of Brazilian lines. State Grid alone represents more than 10% (ONS, 2020b).¹¹

The first Chinese transmission company to arrive in Brazil was Zhejiang Insignia. In December 2010, in partnership with Procable and CEEE-GT, it won a bid to build and operate transmission lines in RS. That is the only tran-

11 The length of transmission lines used here is the one provided by Aneel as of May 2020. The kilometers of lines that are attributed to Chinese actors are not calculated according to the company's share of the consortium. If the Chinese player has the controlling stake of the investment group, the whole line is considered Chinese.

saction of the firm in the period of study. In the winning consortium, it had 40% of the new enterprise Transmissora de Energia Sul Brasil S.A. (TESB) (Aneel, 2020e), a percentage that diminished progressively over time and ended at 6.6% in 2019 (Aneel, 2020d).

One week later, State Grid completed the purchase of seven concessions from the Spanish Plena Transmissora and their 3,250 km of lines (Barbosa, Tepassê, and Biancalana, 2014). From

then on, in a mix of new projects and acquisitions of companies or transmission lines, as shown in table 1, State Grid has consistently expanded its assets, sometimes in partnership with local firms. In 2012, the length of administered lines more than doubled and increased to 7,918 km. With the Belo Monte projects, this number jumped to 12,800 in 2015. From 2017 on, CPFL's transmission projects were incorporated in State Grid's portfolio and the extension of lines reached 14,665 km.

Table 1. State Grid Transmission Lines in Brazil

Date of deal	Concessionaire	Partners	Estimated length (km)	Type of investments	Disinvesting company
dec-10	Itumbiara Transmissora de Energia	None	817	M&A	Plena Transmissora
dec-10	Serra Paracatu Transmissora de Energia	None	246	M&A	Plena Transmissora
dec-10	Poços de Caldas Transmissora de Energia	None	308	M&A	Plena Transmissora
dec-10	Serra da Mesa Transmissora de Energia	None	681	M&A	Plena Transmissora
dec-10	Ribeirao Preto Transmissora de Energia	None	412	M&A	Plena Transmissora
dec-10	Expansion Transmissao de Energia Eletrica	None	575	M&A	Plena Transmissora
dec-10	Expansion Transmissao Itumbiara Marimbondo	None	212	M&A	Plena Transmissora
dec-11	Luziania-Niquelandia Transmissora	Furnas (49%)	0	New	***
mar-12	Matrincha Transmissora de Energia (TP Norte)	Copel (49%)	1005	New	***
mar-12	Guaraciaba Transmissora de Energia (TP Sul)	Copel (49%)	606	New	***
mar-12	Paranaiba Transmissora de Energia	Copel (24.5%), Furnas (24.5%)	967	New	***
may-12	Catxere Transmissora de Energia	None	606	M&A	ACS
may-12	Iracema Transmissora de Energia	None	400	M&A	ACS
may-12	Araraquara Transmissora de Energia	None	30	M&A	ACS
may-12	Linhas de Transmissão do Itatim	None	547	M&A	ACS

may-12	Porto Primavera Transmissora de Energia	None	506.1	M&A	ACS
oct-13	Marechal Rondon Transmissora de Energia	None	33	New	***
feb-14	Belo Monte Transmissora de Energia	Furnas (24.5%), Eletronorte (24.5%)	2092	New	***
jul-15	Atlantico Concessionaria de Transmissao de Energia do Brasil	None	79	M&A	CME, Tecneira
jul-15	Linhas de Transmissao de Montes Claros	None	162	M&A	Cobra Instalaciones
jul-15	Xingu Rio Transmissora de Energia	None	2518	New	***
abr-16	Canarana Transmissora de Energia	None	262	New	***
abr-16	Paranaita Ribeiraozinho Transmissora de Energia	None	1005	New	***
ene-17	Consortio Planalto Transmissao	None	187.3	M&A	CPFL
ene-17	CPFL Transmissao Piracicaba	None	0	M&A	CPFL
ene-17	CPFL Transmissao Morro Agudo	None	2	M&A	CPFL
jun-18	CPFL Transmissao Maracanau	None	2	New	***
dic-18	CPFL Transmissao Sul I	None	320	New	***
dic-18	CPFL Transmissao Sul II	None	85	New	***

Source: Aneel, 2020d; Aneel, 2020e

State Grid's two landmarks – not only in its development in Brazil, but also in the recent history of the Brazilian transmission sector – are the two lengthy lines of the Belo Monte dam.

Belo Monte is the nation's second largest hydropower station and the fourth biggest in the world, with more than 11 GW of installed capacity. Its construction was strategically relevant to the country's energy security: it was planned to help alleviate the bottleneck between supply and demand. On the one hand, Brazil's main electricity consumer market is located in the Southern regions, where historically most of the hydropower stations were built and the local electricity generation potential is already well developed. On the other hand, the country's new frontier for large-scale hydropower projects is in the Amazon basin, a region

not densely populated and whose generation potential has not yet been fully realized. Estimates show that around 70% of untapped hydropower resources are located in the North of the country (Aneel, 2008). Belo Monte was planned to help equilibrate this delicate balance, but its location in PA, far from the South, has created an additional layer of challenge: transmission of electricity over great distances (Cote, 2014).

State Grid's expertise and technical experience in long-distance transmission lines in China have matched with Brazil's necessity of upgrading its national power grid, which had been facing hurdles over the years, as the 2009 blackouts have shown (Husar and Best, 2013). China has also confronted the challenge of unequal distribution of renewable energy resources and load

centers, which was overcome with the deployment of ultra-high voltage technology (UHV, 800kV) (Proenca and Kupfer, 2018; Cui and Zheng, 2019).

Belo Monte’s transmission line project had two phases. Phase I involved the construction of nearly 2,100 km of lines from Xingu (PA) until Estreito (MG) and was inaugurated in December

2017 by the consortium Furnas (24.5%), Eletronorte (24.5%), and State Grid (51%). Phase II’s more than 2,500 km of lines from Xingu to Rio de Janeiro were built by State Grid alone and completed in June 2019. Both phases mark the first time that an 800 kV UHV transmission line is operated in another country by State Grid, which owns the concession for thirty years (Hiratuka, 2018).

Table 2. EDP Transmission lines in Brazil

Date of deal	Concessionaire	Partners	Estimated length (km)	Type of investment	Disinvesting company
oct-16	EDP Transmissao S.A.	None	113	New	***
abr-17	EDP Transmissao MA I S.A.	None	128	New	***
abr-17	EDP Transmissao Alianca SC	None	753	New	***
abr-17	EDP Transmissao SP-MG	None	750	New	***
abr-17	EDP - Energias do Brasil S.A.	None	203	New	***
may-19	EDP Transmissao Litoral Sul S.A.	None	164	M&A	CEE Power, Brafer

Source: Aneel, 2020e; Aneel, 2020d

CTG’s footprint in Brazil’s transmission sector started in 2016 and through EDP, which has built its portfolio of approximately 2,111 km of lines through new projects and purchase of local companies, such as Litoral Sul Transmissora de Energia (EDP, 2019) and Celesc (EDP, 2018), both in SC, as shown in table 2.¹²

Geographically speaking, Chinese firms are present in all five regions, in 16 states. State Grid

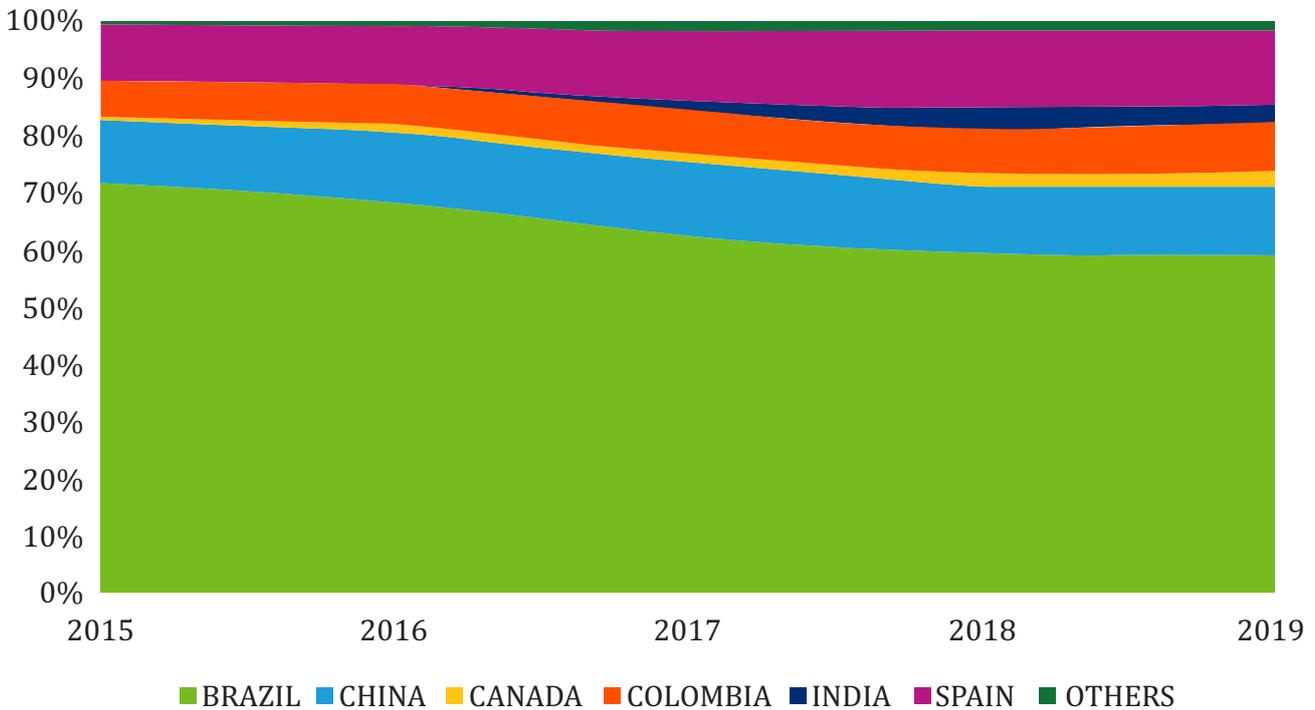
is the only one active in all regions, 14 states in total. CTG/EDP is concentrated in Southern states (such as RS, SC, SP, ES, MG), where historically EDP has a traditional stance, with the exception of a project between Maranhao (MA) and TO. Zhejiang Insigma possesses only one project in RS.

It is interesting to put Chinese investments in Brazil’s transmission sector in perspective and evaluate the changes of the segment as a whole during the last few years. As in generation, there is a continuous process of internationalization of the segment over time, with foreign players expanding their projects in the country (figure 8).¹³

¹² Shanghai Electric had plans to invest in Brazil’s transmission sector. In November 2017, in partnership with CLAI Fund, the firm signed an agreement with the state-owned Eletrosul, in order to jointly invest, construct, operate, and maintain 1,900 km of lines in RS. Both Chinese players would have 69% of the new society. Zhejiang Energy has also showed interest in the transaction. However, all Chinese actors decided to withdraw from the deal (Aneel, 2018).

¹³ A concessionaire’s nationality is defined according to the company or group of companies from the same country that have the majority of the controlling shares of the local transmission firm (Aneel, 2020d).

Figure 8. Countries' percentage of the transmission sector (km of transmission lines)



Source: Aneel, 2020d; Aneel, 2020e

Chinese firms as a whole possessed roughly 12% (16,590 km) of the national grid in 2019, ranking third place, after Brazilian (60%) and Spanish (13%) players. Their development happened in a faster rhythm than other competitors, especially considering that their investments started in 2010, well after their international peers. Colombian (9%) and Indian (3%) actors have equally experimented a rapid development over time (Aneel, 2020d).

DISTRIBUTION

Chinese companies' arrival in Brazil's electricity distribution sector coincides with the generation segment. The 2011 CTG's acquisition of EDP gave the former indirect assets in two local concessionaires: EDP ES and EDP SP. At the end of 2019, six other regional corporations – out of 109 – have also Chinese full or partial ownership, namely Celesc, RGE, RGE Sul, CPFL Paulista, CPFL Jaguari, and CPFL Piratininga (Aneel, 2020d).

CTG and State Grid are the only Chinese firms with investments in distribution and all their transactions come from M&A. Since 2011, CTG's assets are through EDP Brasil, which fully owns EDP Sao Paulo Distribuicao de Energia and EDP Espirito Santo. They provide electricity to SP and ES correspondingly. In 2018, EDP Brasil started to buy shares of Centrais Eletricas de Santa Catarina (Celesc) and ended up with 33.1% (EDP, 2018).

State Grid's presence started in 2017, with the acquisition of CPFL, which, as in the generation sector, was equally strategic to the company's expansion in the distribution segment. CPFL is historically one of the biggest electricity providers. A few months before this transaction, it had just assumed the full control of RGE Sul Distribuidora de Energia and RGE Rio Grande Energia, both located in RS (Costa, 2016). With CPFL's acquisition, the number of consumer units attended by Chinese firms expanded more than seven times.

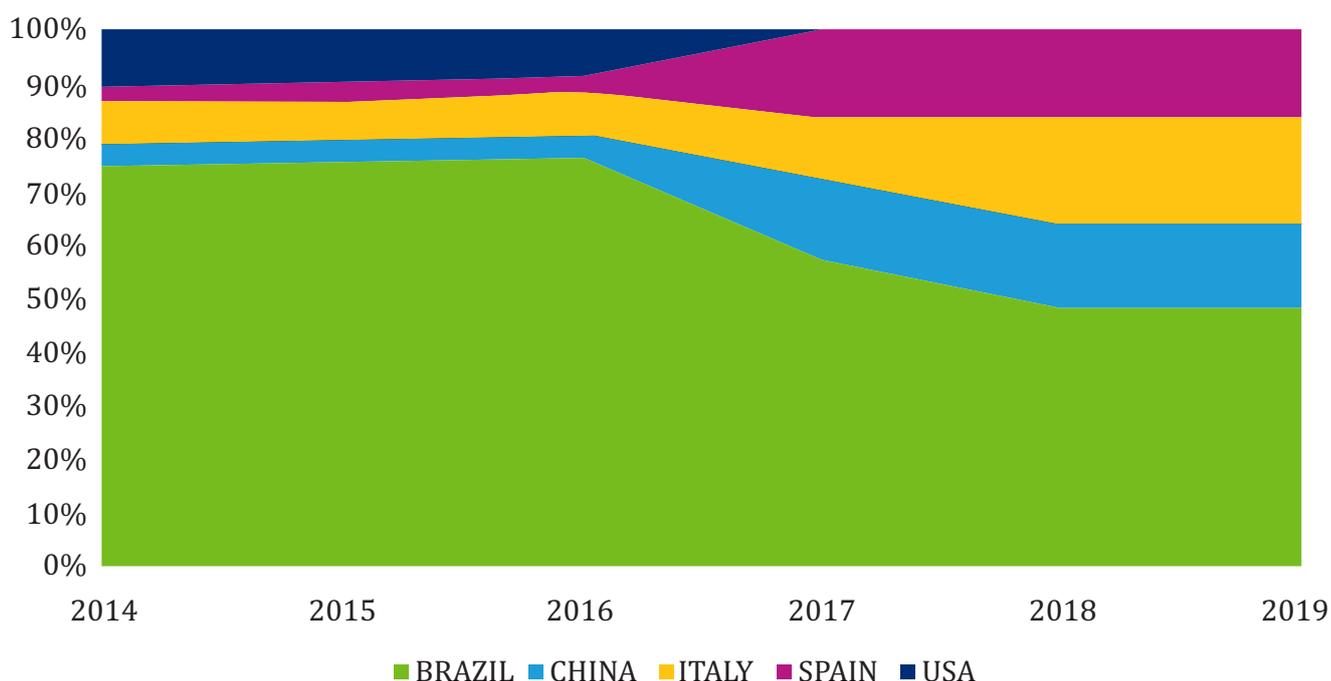
Considering each Chinese company’s shares in their local concessionaires¹⁴, State Grid and CTG have the equivalent of 114 and 12 million consumer units, respectively. In sum, they represented in 2019 roughly 12% of Brazil’s distribution sector’s consumer units. Separately, the former accounted for 11%, and the latter, 1% (Aneel, 2020f).

Chinese companies are present in four states, with are strategically important ones, since they have large populations, high GDP and higher electricity consumption rates. These firms’ share in each of them has varied over time. In ES, EDP ES is the leading company. Considering CTG’s indirect share of it, Chinese participation in the local distribution sector is around 20%, a percentage that has remained

stable over the years. In SP, Chinese participation started small, roughly 2% until 2016, but augmented considerably after 2017 – with CPFL’s acquisition –, ending 2019 with 38%. In SC, Chinese participation started in 2018, when EDP partially bought 7% of Celesc. Finally, in RS, participation only started in 2017 and has remained 58% until 2019. This is due the fact that RGE – owned by State Grid – is the state’s major concessionaire.

Examining data about the ownership structure of each of the one hundred plus distribution concessionaires in Brazil between 2014 and 2019¹⁵, figure 9 shows a process of continuous internationalization of the segment, with foreign actors increasingly augmenting their stakes over time.¹⁶

Figure 9. Countries’ percentage of the distribution sector (number of consumer units)



Source: Aneel, 2020d; Aneel, 2020f

¹⁴ The number of consumer units administered by Chinese firms is estimated according to the company’s share in each local concessionaire/plant.

¹⁵ Period of time that there is complete data available as of May 2020.

¹⁶ A concessionaire’s nationality is defined here according to the company or group of companies from the same country that have the majority of the controlling shares of the local distribution firm.

Besides China, there are basically three other countries whose corporations have been traditionally present in the Brazilian distribution sector: Italy, Spain, and USA. US firms and investment funds have been consistently investing in Brazil's energy sector since its first wave of privatization, in the late 1990's. One of the main actors was AES group, with assets across all electricity segments. AES was the former owner of Eletropaulo and RGE Sul, which were acquired by Enel and CPFL respectively (CPFL, 2016), leaving the US with no other major assets in Brazil. Between 2014 and 2017, the share of the country remained a little less than 10%.

Like the Chinese, Spanish and Italian firms have made big strides over the last few years. The main Italian player is state-controlled Enel. After two big acquisitions in 2016 and 2018 – respectively Celg-D (in Goias) and Eletropaulo (SP) –, it became Brazil's largest electricity distributor. The share of Italian companies between 2014 and 2019 varied from 7% to 20%.

The leading Spanish player is Iberdrola, which has investments in different electricity segments. In distribution, it arrived in the early 2000's and in the last few years has increased its shares and assumed bigger controlling stakes in its concessionaires. The share of Spanish firms between 2014 and 2019 grew from 3% to 17%.

A noteworthy feature of these shifts of ownership in the distribution sector is the nature of the companies involved. On the one hand, the decrease of Brazil's proprietorship shares in the segment happened mainly at the expense of domestic government-owned corporations, whose assets were partially privatized over time. On the other hand, foreign state-controlled firms were the major buyers of these concessionaires, as is the case of Enel and State Grid. By the end of 2019, these firms possessed roughly 36% of the entire sector.

CONCLUSION

The paper provides a thorough portrait of Chinese presence in Brazil's electricity sector, how deep China has penetrated in each three segments (generation, transmission, and distribution) from 2010 to 2019, and to analyze the importance of Brazil in Chinese electric power companies' global expansion.

It shows that an internationalization process in the Brazilian electricity sector was already going on when Chinese power electric firms disembarked and joined the already under-expansion club of investors. Their growth was impressive and much faster than other competitors over the last ten years. As of 2019, they were the main foreign players in the South American country, where they are responsible for roughly 10%, 12%, and 12% of the local generation, transmission, and distribution, or 16,736 MW, 16,776 km of lines, and 126 million consumer units respectively. Chinese players have reached the second, third, and fourth places in terms of nationalities' percentage of each segment, according to Brazilian official data.

This articles also debates that Brazil became a strategic part of Chinese electric firms' global plans. The South American country concentrates the majority of China's global power properties. State Grid, CTG, CGN, and SPIC have invested heavily there and possess roughly 57%, 39%, 6%, and 10% of their overseas power generation assets respectively there.

This paper argues that, as a distinct pattern, these corporations focus their energy investments where Brazil has a natural advantage or an abundance of resources: renewable energy. 70% of China's installed capacity is in hydroelectric generation. Chinese non-renewable energy facilities in Brazil amount to 4% of their total in the country. Elsewhere – including inside China itself –, non-renewables have received most of Chinese power firms' investments (64%), with a focus on coal power (79,500 MW in 107

plants worldwide) (Gallagher, 2019). There is only one coal-based Chinese asset in Brazil.

Based on these ten years' experience and the long-term business commitments made by Chinese power companies, it is hard not to predict that, in the coming decade, they will have an important role in the continuous development of the Brazilian electricity sector, where Chinese exploration and operation rights will last for at least thirty years. Brazil's still expanding electricity consumer market and infrastructure expansion necessities constitutes an attractive scenario for players with a long-term strategic sight. ■

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