An overview on the brazilian electricity production based on biomass

Uma visão geral sobre a produção brasileira de eletricidade com base na biomassa

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ABSTRACT
In Brazil, renewable sources have gradually assumed an important role in the generation of electricity. This work aims to present the main sources of biomass used for electricity production in the country such as sugarcane, black liquor, forest residue, charcoal, rice hulls, elephant grass, biogas (animal and agriculture waste) and biomass for blast furnace gas generation. Based on official data, the article presents the main biomass sources for

electricity production, their power generation capability and respective geographical location along the country. Additionally, the names of main power generation plants based on biomass are listed, and their characteristics are discussed.

Keywords: electricity generation, biomass sources, renewable energy, global demand for electricity, brazilian electricity production.

RESUMO
No Brasil, as fontes renováveis têm gradualmente assumido um papel importante na geração de eletricidade. Este trabalho visa apresentar as principais fontes de biomassa utilizadas para a produção de eletricidade no país, tais como cana-de-açúcar, licor negro, resíduos florestais, carvão vegetal, casca de arroz, capim-elefante, biogás (resíduos animais e agrícolas) e biomassa para geração de gás de alto-forno. Com base em dados oficiais, o artigo apresenta as principais fontes de biomassa para a produção de eletricidade, sua capacidade de geração de energia e sua respectiva localização geográfica ao longo do país. Além disso, são listados os nomes das principais usinas de geração de energia elétrica baseadas em biomassa, e suas características são discutidas.

Palavras-chave: geração de eletricidade, fontes de biomassa, energia renovável, demanda global por eletricidade, produção de eletricidade no Brasil.

1 INTRODUCTION

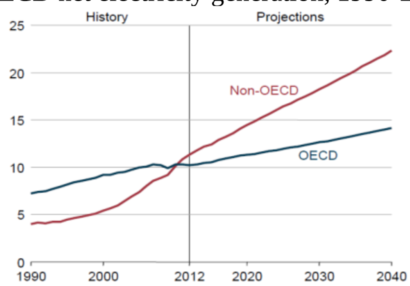
Approximately 1.1 billion people worldwide do not have access to electricity. The “World Bank's Sustainable Energy for All” initiative seeks to provide universal access to energy by the year 2030 (BANERJEE, S.G. *et al*, 2020). The current world population of 7.3 billion is projected to reach 8.5 billion by 2030 and 11.2 billion by 2100. As non-renewable energy reserves decline globally, the transition to a renewable energy infrastructure will develop at different times in each world region (WARNER, K.J. *et al*, 2017).

According to IEA (*International Energy Agency),* deep disparities define today’s energy world: oil markets and geopolitical tensions, carbon emissions and climate targets, the promise of energy for all and the lack of electricity access for 850 million people around the world. Compared with the past twenty-five years, the way that the world meets its growing energy needs changes dramatically, with the lead now taken by natural gas, by the rapid rise of renewables and by energy efficiency (INTERNATIONAL ENERGY AGENCY, 2020). Approximately 82% of world energy demand is met by fossil energy sources, such as oil, coal, and natural gas. As the increase in global energy demand was greater than the increase in population in the last century (ONG, H.C *et al*, 2011), the dependence of economies on fossil energy sources induced some political, economic, and environmental concerns (QIN, Z, *et al*, 2012). One concern is that fossil energy supply is restricted. The industrialization, high growth rates of population and urbanization, and the developments in transportation, accelerate the use of coal, oil, and natural gas. Global energy demand doubled from 1970 to 2000 and increased by 26% from 2000 to 2010. Therefore, the issue of meeting energy demand is particularly important with regard to sustainable development (FAIK, B *et al*, 2017).

In the last decades, the share of renewable energy sources in the energy mix has risen significantly in many countries, and the large-scale integration of these intermittent energy sources constitutes a major challenge to the power grid. A crucial building block of a successful transformation of today's energy systems is the use of energy storage, either co-located with renewable energy sources or on a grid-level (HASSLER, M, *et al*, 2017). It is important to point out that such predictions were made before the appearance of the novel coronavirus (SARS-CoV-2), and the corona virus disease COVID-19, which may impact this analysis at least in the short term.

Economic growth is an important factor in electricity demand increase. In 2012, electricity generation in non-OECD countries represented slightly more than one-half of world electricity demand. With continued strong economic growth, the non-OECD share of world electricity generation increases to 61% in 2040 as can be observed in Figure 1, as total non-OECD electricity generation nearly doubles, from 11.3 trillion kWh in 2012 to 22.3 trillion kWh in 2040 (U.S. ENERGY INFORMATION ADMINISTRATION, 2020).

Figure 1– OECD and non-OECD net electricity generation, 1990-2040 (trillion kilowatt-hours)



Source: U.S. Energy Information Administration (EIA), 2020

One major challenge for many industrialized and developing countries today is the large-scale integration of renewable energy sources into the energy mix in order to satiate the increasing demand for electric power. The participation of renewable sources in the world matrix presents is of 13.7%. In Brazil, this share rises to 43.5%. This difference is motivated by a significant participation of hydroelectric generation and sugarcane fueled thermoelectric power plants on the Brazilian energy matrix. Energy from hydropower systems is the main source of the Brazilian electricity power generation corresponding to 59.7% of the total installed capacity. Wind energy represents 9.1% and photovoltaic 1.7%, as can be observed in Table 1

Table 1- Brazilian energy matrix

Source	Supervised power (MW)	Quantity	% (Sup. Power)
Wind power	15,722.5	962	9.11
Small hidroelectric units	5,300.9	546	3.07
Photovoltaic energy	2,928.0	4,166	1.70
Hydropower plant	103,002.9	223	59.67
Thermoelectric plant	42,866.2	3,167	24.83
Others	2,792.7	744	1.62
Total	172,613.1	9,808	100.00

Source: Agência Nacional de Energia Elétrica a, 2018.

2 THE BRAZILIAN ELECTRICITY SECTOR

Electricity started to be relevant for Brazil since the 1920's. At first, it was an uncoordinated development and subject to sparse and individual initiatives. In 1934, the Brazilian central government took the responsibility to support the electricity industry development (TOLMASQUIM, M.T, 2015). In the 1970's large-scale projects were built in Brazil involving huge investments.

The institutional model of the Brazilian electric power, sector has undergone two major changes since the 1990's. The first change involved the privatization of several utilities that operated in the country based on the Law No. 9427 of December 1996. The second change occurred in 2004, with the introduction of the New Model of the Electric Sector, whose main objectives were: the guarantee of supply security, and the promotion of moderate tariffs and social insertion. As a result, generation companies started to sell their energy in the free market (AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA b (ANEEL), 2018).

In Brazil, while generation capacity has grown by 44% since 2004, nationwide electricity consumption has grown by almost 53%, coinciding with a period of accelerated economic development and social inclusion. The Brazilian electrical grid allows the produced energy exchange among all regions, except in some isolated systems, which are located mainly in the Northern region. Energy transmission is possible thanks to the National Interconnected System (SIN), a large transmission network with more than 180,000 km of extension. The localities of the isolated system have been gradually interconnected over the years. Nowadays only about 2% of the national market remains isolated from the national grid (AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA c (ANEEL, 2018).

3 METHODOLOGY

The aim of this study is to present the biomass use in Brazil for electricity generation purposes. To better understand the participation of the various Brazilian sources of electricity generation, the results of this work are shown by graphical representation in maps. The maps were created to show the electricity generation potential, in kW, and the respective biomass sources of power generation. The official power data for each electricity generation plant shown in the maps are named as "supervised power".

The source of the data and tables is the official SIGA – Banco de Informações de Geração (AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA, BIG, 2020) and the Portal de Geoprocessamento (AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA (ANEEL), SIGEL, 2020) both under the administration of ANEEL the Brazilian Electricity Regulatory Agency.

Software R was used to generate the maps. *R* is a language and environment for statistical computing and graphics, available as free *software* under the terms of the Free *Software* Foundation's GNU General Public License in source code form (R Core Team, 2020).

The electricity production regions are represented by circles in the maps. The power values are distributed in different levels and the dimensions of the circles are proportional to these power levels. Data, as of April 2020.

4 RESULTS AND DISCUSSION

Next sections are focused on the main biomass-based sources for electricity production in Brazil, namely sugarcane, black liquor, forest residue, charcoal, rice hulls, elephant grass, biogas (animal and agriculture waste) and biomass for blast furnace gas generation.

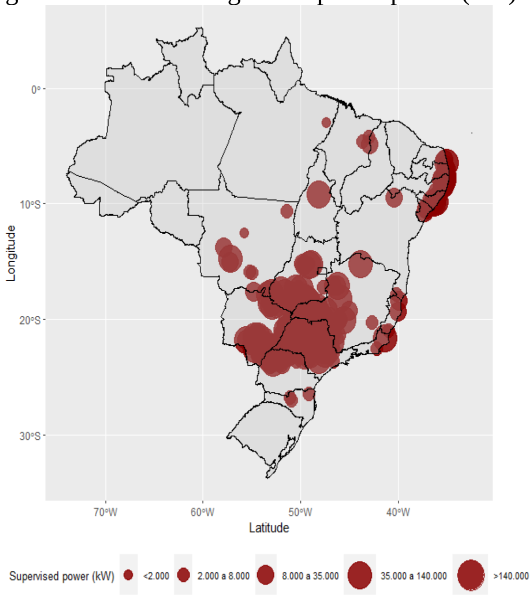
4.1 SUGARCANE

In regional terms, Brazil presents two distinct harvest periods: from September to March for the Northern and Northeastern regions, and from April to November in the Center-Southern regions. Thus, the country produces ethanol practically throughout the year. Fegure 2shows the location of the country's plants which produce bioelectricity, with a clear concentration in the Zona da Mata, in the Northeastern region, and in the São Paulo State, in the Southeastern region. In general, the sugarcane cultivation areas are located within a 25 km radius of the mills, on average, mainly due to transportation costs (COMPANHIA NACIONAL DE ABASTECIMENTO, 2018).

The Southeastern region, the largest national producer, accounted for 74.6% of the sugar produced in the country, followed by the Central-Western region (10.9%), the Southern (7.7%) and the Northeastern (6.6%). São Paulo, Minas Gerais, Paraná, Goiás, Mato Grosso do Sul and Alagoas States are the largest sugar producers with production of over 1 million tons per harvest (AGÊNCIA EMBRAPA DE INFORMAÇÃO TECNOLÓGICA, 2020).

According to AGEITEC - Embrapa's Information Technology Development Agency, the São Paulo State, the largest national producer, presents diverse conditions and climate restrictions for sugarcane farming. There are areas where the climate is considered ideal for planting, without any restrictions. The ideal soil temperature for the sugarcane is 32 to 38 °C (Celsius). For optimal, strong, and vigorous growth which guarantees high production and high yields of sugar, the average daytime temperature should be between 22 to 30 °C. The minimal temperature for optimal vegetative development should be approximately 20 °C. For temperatures below 20 °C production is impaired. As for soil moisture, an adequate supply of water is essential for sugarcane growth. The water needs for sugarcane ranges from 1,500 to 2,500 millimeters, which must be uniformly distributed during the period of vegetative development, according to data provided by the United Nations Food and Agriculture Organization (FAO). However, recent studies have shown that the amount of water required for the crop to reach its maximum potential is around 1,200 to 1,300 millimeters (AGÊNCIA EMBRAPA DE INFORMAÇÃO TECNOLÓGICA, 2020).

Figure 2 – Brazilian sugarcane power plants (kW)



Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

Table 2 presents the main companies that produce electricity by sugarcane biomass in Brazil and its supervised power. As can be observed, the Southeastern region has the highest concentration on the map.

Table 2 – Main electricity generation plants in Brazil based on cane bagasse.

Company	Region	State	Sup. Pow. (MW)
Porto das Águas	Chapadão do Céu	GO	160.0
Eldorado	Rio Brilhante	MS	140.0
Barra Bioenergia	Barra Bonita	SP	136.0
Cocal II	Narandiba	SP	131.3
Caçú I	Caçu	GO	130.0
Santa Luzia I	Nova Alvorada do Sul	MS	130.0
Caarapó	Caarapó	MS	114.0
Usina Bonfim	Guariba	SP	111.0
Conquista do Pontal	Santo Anastácio	SP	110.0
Colombo Ariranha	Ariranha	SP	105.5
Jataí	Jataí	GO	105.0

Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

The biomass thermoelectric power plant, Porto das Águas, is controlled by Cerradinho Açúcar, Etanol e Energia. It produces steam with a boiler in a regenerative cycle system that allows the burning of alternative raw materials such as wood chips, grass and other sources of carbon (JORNAL DA CANA, 2020). The Eldorado Brasil unit in Três Lagoas (Mato Grosso do Sul State) is completely self-sufficient in electricity produced from renewable sources. Cocal is a 100% Brazilian company. The electricity is produced by cogeneration from the excess vapor of sugarcane bagasse and other types of biomasses (ELDORADO BRAZIL, 2020). The Santa Luzia plant is a unit of Odebrecht

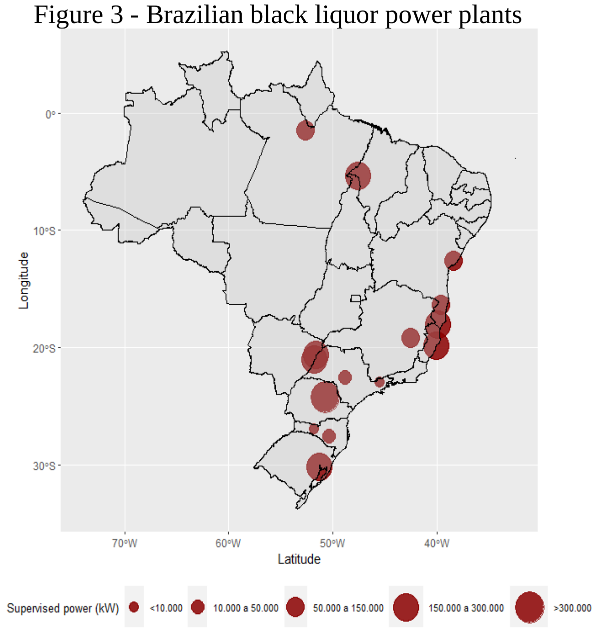
Agroindustrial (CANAONLINE, 2019). The Ivinhema 2 Thermoelectric Set consists of the Amandina UTE which is composed by two generating units of 40 MW each, totaling 80 MW, and UTE Amandina II which is composed by one generating unit of 40 MW (OPERADOR NACIONAL DO SISTEMA ELÉTRICO, 2019).

4.2 BLACK LIQUOR

Black liquor is a byproduct resulting from the Kraft pulping process after lignin and hemicellulose are removed from the cellulose fibers. A considerable amount of black liquor is produced during the Kraft pulping process: seven tons per ton of pulp. Black liquor is currently burned in boilers to produce steam and electricity in pulp mills, and the excess of electricity can be injected into the grid, therefore generating additional revenue. By producing a high heating value synthesis gas (syngas), BLG (black liquor gasification) is more energy efficient overall than conventional recovery boilers (SPEIGHT, J.G, 2014). When syngas from BLG is burned in a gas turbine-based gasification combined cycle plant, electricity is generated (similar to an integrated gasification combined cycle [IGCC]) and the process is called black liquor gasification combined cycle (BLGCC). Previous studies have shown that the BLGCC integrated with the pulp mill has potential to achieve higher energy efficiency than conventional recovery technology. If the syngas is further processed, it can be converted to even higher value products such as dimethyl ether (DME), Fischer-Tropsch diesel (FTD), methanol, syngas (SNG), hydrogen, and ammonia (AKBARI, M, *et al*, 2018).

As can be observed in Figure 3, the main electricity generation from black liquor is located in Paraná (Klabin), followed by Fibria, in Mato Grosso do Sul. Both are paper pulp producers. Table 3 shows the main electricity producers in Brazil, by black liquor.

Figure 3 - Brazilian black liquor power plants



Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

Table 3 - Main electricity generation plants in Brazil based on black liquor

Company	Region	State	Sup. Pow. (MW)
Klabin Celulose	Ortigueira	PR	330.00
Fibria MSII	Três Lagoas	MS	269.58
Suzano Maranhão	Imperatriz	MA	254.84
CMPC	Guaíba	RS	250.99
Eldorado Brasil	Três Lagoas	MS	214.10
Suzano Mucuri	Mucuri	BA	214.08
Aracruz	Aracruz	ES	210.40
Fibria MS	Três Lagoas	MS	175.10

Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

Klabin produces cellulose from pine (Pinus Taeda and Pinus Elliottii) and eucalyptus (Eucalyptus Grandis, Saligna and Dunnii) trees (MOURAD, A. L *et al*, 2014). The company produces cellulose and paper. The industrial process of a pulp mill essentially consists of the extraction and processing of the fiber - the plant compound that constitutes the cellular wall of the wood, in this case, eucalyptus (CMPC, 2020). The industrial complex of Eldorado Brazil in Três Lagoas (MS) is completely self-sufficient in electricity, with production from renewable sources. The generation of energy is carried out by the reuse of the unused biomass in the factory, which is then processed in special boilers in order to generate steam for electricity production purposes (ELDORADO BRAZIL, 2020).

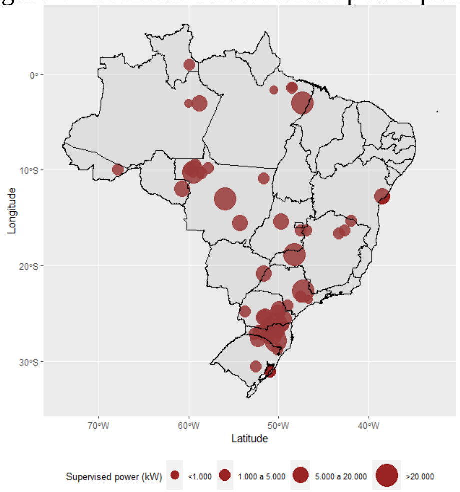
4.3 FOREST RESIDUE

Brazil is one of the world's largest producers of trees planted for industrial processing purposes. In 2016, the planted area for industrial purposes reached 7.84 million hectares in the country. An increase of 0.5% compared to 2015 (LOUZADA *et al*, 2017).

The Forest Sector in Brazil is deeply based in the supply of wood from commercial planted forests since the management of natural forests (mainly the Amazon region) has been destined for an increasingly restricted market for high-quality solid wood and expressive commercial added value.

The two main species cultivated in Brazilian forestry are the exotic species eucalyptus and pine wood, the main purpose of this forestry activity is the production of pulp and paper, charcoal, and wood residues (Figure 4) are used for electricity generation all over the country.

Figure 4 - Brazilian forest residue power plants



Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

The main source of forest residues and their respective supervised power are presented in Table 4.

Table 4 – Main electricity generation plants in Brazil based on forest residue

Company	Region	State	Sup. Pow. (MW)
Ripasa	Limeira	SP	53.48
Rigesa	Três Barras	SC	32.50
F&S AgriSolutions	Lucas do Rio Verde	MT	30.00
Guaçu	Aripuanã	MT	30.00
Lages	Lages	SC	28.00
Cargill	Uberlândia	MG	25.00
Floraplac	Paragominas	PA	20.00

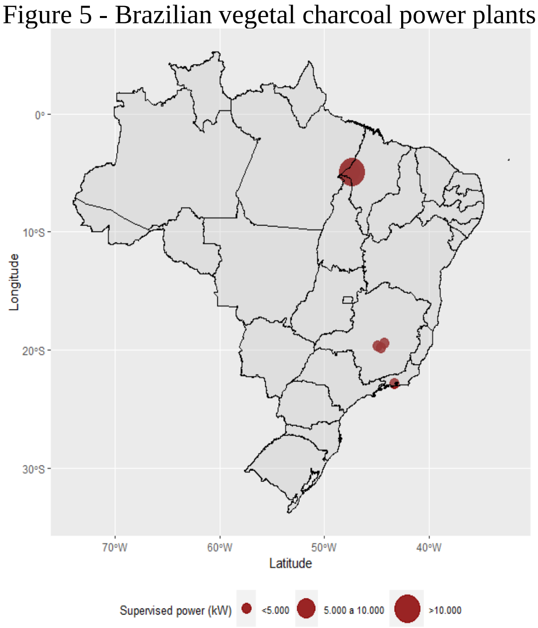
Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

The Southern and Southeastern regions lead the use of forest residue. Ripasa is part of Suzano Pulp and Paper Group. Suzano is a forestry-based company and one of the largest integrated producers of cellulose and paper in Latin America (SUZANO, 2020). FS Bioenergia produces ethanol, animal nutrition and corn oil (FSBIOENERGIA, 2020). Rigesa is part of WestRock group and the second largest paper company in Brazil (WESTROCK, 2020), (WEG, 2020).

4.4 CHARCOAL

Charcoal is one of the biomass sources in Brazil and its geographical location is presented in Figure 5. The wood is already used with a significant contribution in the Brazilian energy matrix, considering the consumption of steel and other industries that require thermal energy in their processes.

Figure 5 - Brazilian vegetal charcoal power plants



Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

Table 5 shows that Maranhão and Minas Gerais States are the main electricity producers from charcoal in Brazil.

Table 5 - Main electricity generation plants in Brazil based on charcoal

Company	Region	State	Sup. Pow. (MW)
Viena	Açailândia	MA	12.2
Gusa Nordeste	Açailândia	MA	10.0
Simasa	Açailândia	MA	8.0
Usipar Ind. e Comércio	Pitangui	MG	5.0
AVG I-II	Sete Lagoas	MG	4.8

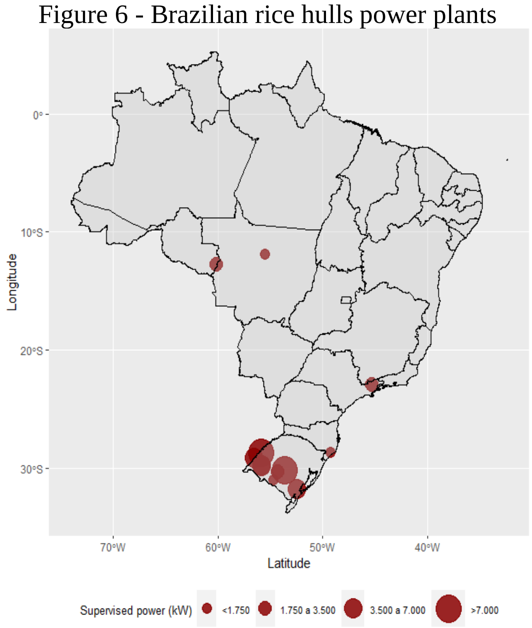
Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

Gusa Nordeste reuses all the resulting vegetal residue at the plant for pig iron production (AÇO VERDE DO BRASIL, 2020). Viena and Simasa also carry out reforestation, reuse of charcoal fines and thermoelectric power generation (VIENA, 2020), (MINISTÉRIO DO MEIO AMBIENTE, 2020).

4.5 RICE HULLS

As can be observed in Figure 6, Rio Grande do Sul State, as one of the largest national rice producers in Brazil, concentrates most of rice hull fueled power plants.

Figure 6 - Brazilian rice hulls power plants



Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

The city of São Borja, in the Rio Grande do Sul State, has the largest thermoelectric power plant based on rice hulls in Brazil as can be observed in Table 6.

Table 6 - Main electricity generation plants in Brazil based on rice hulls

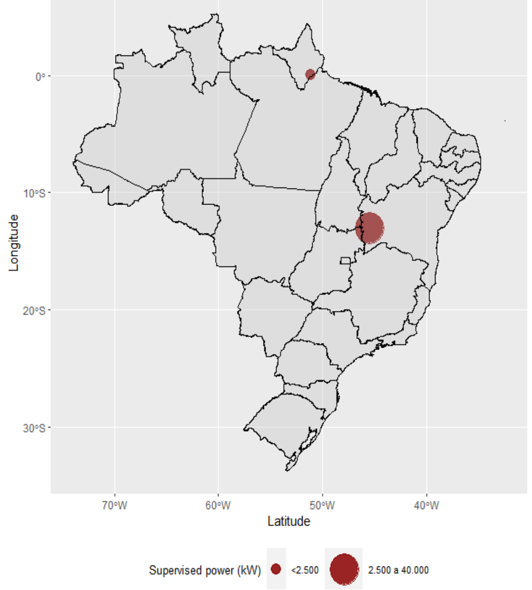
Company	Region	State	Sup. Pow. (MW)
São Borja	São Borja	RS	12.5
São Sepé	São Sepé	RS	8.0
Urugaiana	Uruguaiana	RS	8.0
PCT SLC Alimentos	Capão do Leão	RS	5.8
SVA	Alegrete	RS	4.9
Camil Alimentos - Camaquã	Itaqui	RS	4.0
CAAL	Alegrete	RS	3.8

Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

4.6 ELEPHANT GRASS

Elephant grass (Pennisetum purpureum) is a forage grass with high photosynthetic efficiency discovered in 1905 by Colonel Napier in tropical Africa which was introduced in Brazil in 1920 and is now widespread throughout the country. Being a perennial grass, it does not need replanting after each harvest and reaches 3-5 m tall with 2 cm in diameter within 180 days. An elephant grass crop can produce up to 29.05 tons of dry matter per hectare per year with 15% of moisture content (FONTOURA, C.F, *et al*, 2015).

Figure 7 - Brazilian elephant grass power plants



Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

In Brazil, as observed in Figure 7and Table 7 , elephant grass energy production is concentrated in Mato Grosso and Bahia. Agrenco is a group of companies related to international agribusiness. The Sykué Bioenergya plant, under a Brazilian investment, started operations in 2010.

Table 7 - Main electricity generation plants in Brazil based on elephant grass

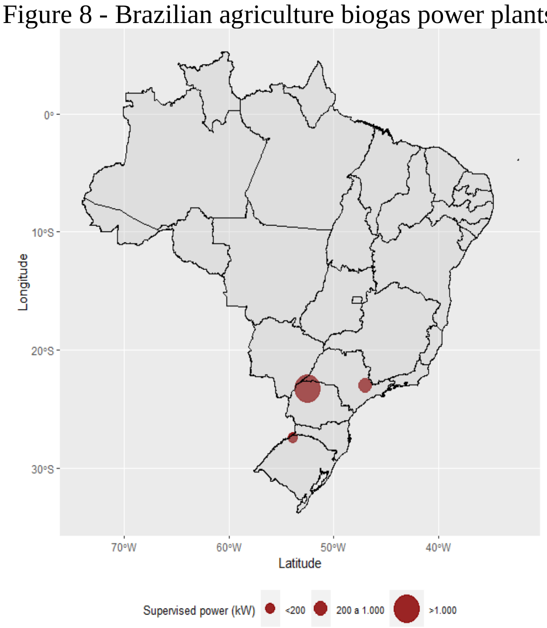
Company	Region	State	Sup. Pow. (MW)
Agrenco	Alto Araguaia	MT	34.0
Sykué I	São Desidério	BA	30.0
Flórida Clean Power	Macapá	AP	1.7

Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

4.7 BIOGAS AW – (AGRICULTURAL WASTE)

Figure 8 and Table 8 show data related to agriculture biogas power plants in Brazil.

Figure 8 - Brazilian agriculture biogas power plants



Source: Agência Nacional de Energia Elétrica

Table 8 - Main electricity generation plants in Brazil based on agriculture waste

Company	Region	State	Sup. Pow. (MW)
Geo Elétrica Tamboara	Tamboara	PR	7.00
Cogeração Biospringer	Valinhos	SP	1.70
Adelar Piaia	Três Passos	RS	0.10

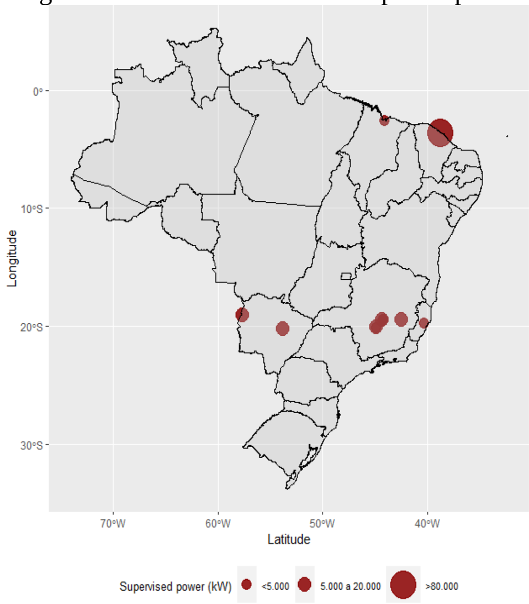
Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

GEO Energética is a 100% Brazilian company that has developed a unique and innovative biotechnological process for biogas production from reusing agroindustry waste. Biospringer is a business unit of the French group Lesaffre. Two Jenbacher engines with a capacity of 846 kW of electrical power allow the company to be autonomous in electricity and heat needs for the industrial process (GEO ENERGÉTICA, 2020).

4.8 BIOMASS FOR BLAST FURNACE GAS GENERATION

Blast furnace gas is a by-product of blast furnaces where iron ore is reduced with coke into metallic (pig iron). Figure 9 and Table 9 show the main electricity generation plants in Brazil based on blast furnace.

Figure 9 – Brazilian blast furnace power plants



Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

Table 9 - Main electricity generation plants in Brazil based on blast furnace

Company	Region	State	Sup. Pow. (MW)
CSP	São Gonçalo do Amarante	CE	218.00
Us. térmica Ipatinga	Ipatinga	MG	40.00
Usiminas	Ipatinga	MG	18.81
Barreiro	Belo Horizonte	MG	12.90
Vetorial Corumbá	Corumbá	MS	10.00

Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

The Companhia Siderúrgica do Pecém (CSP) is a bi-national joint venture formed by Brazil's Vale (50% stake), and both South Korean's Dongkuk (30%), and Posco (20%).

The Ipatinga plant belongs to Usiminas and its production is basically focused on pig iron.

4.9 BIOGAS RA (ANIMAL WASTE)

The use of biological and thermochemical conversion (TCC) technologies in livestock waste-to-bioenergy treatments can provide livestock operators with multiple value-added, renewable energy products. Dairy cow or swine manure are important resources in the generation of renewable energy. The manure is collected and heated, creating methane gas as a renewable fuel for electricity production. Figure 10 and Table 10 present geographically the waste power plants located in Brazil.

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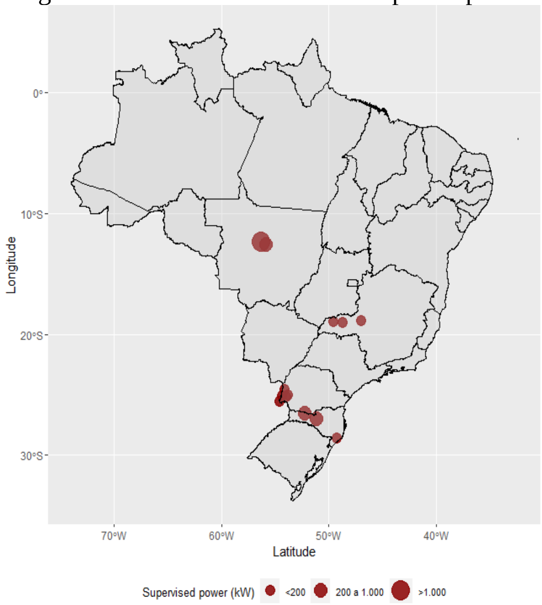
Figure 10 - Brazilian animal waste power plants



Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

Table 10 - Main electricity generation plants in Brazil based on animal waste

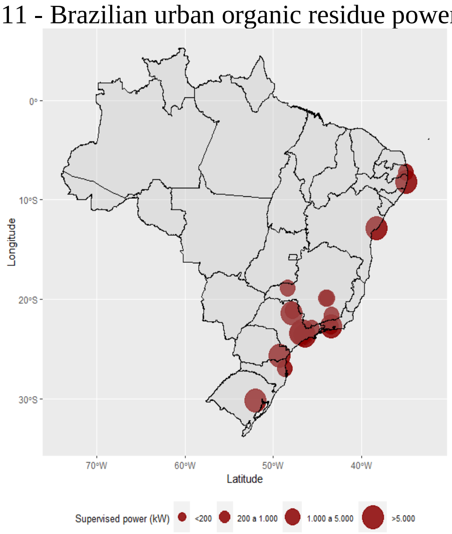
Company	Region	State	Sup. Pow. (MW)
Ipiranga do Norte I	Tapurah	MT	1.56
Fazenda da Luz	Abelardo Luz	SC	0.81
Nossa Senhora Aparecida I	Sorriso	MT	0.78
Granja São Roque	Videira	SC	0.42

Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

4.10 BIOGAS URBAN ORGANIC RESIDUE

Urban Organic Solid Residue or Bio-Residues are organic residues of animal or vegetable origin, generated in households or companies and that can be degraded by microorganisms generating biogas and biofertilizers. Figure 11 and Table 11 present the supervised power for electricity production based on urban residues.

Figure 11 - Brazilian urban organic residue power plants



Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

Table 11 - Main electricity generation plants in Brazil based on urban residues

Company	Region	State	Sup. Pow. (MW)
Termoverde Caieiras	Caieiras	SP	29.547
São João Biogás	São Paulo	SP	24.640
Salvador	Salvador	BA	19.730
Nova Iguaçu	Nova Iguaçu	RJ	16.932
Asja Jaboatão	Jaboatão dos Guararapes	PE	14.260
Biotérmica Recreio	Minas do Leão	RS	12.744

Source: Agência Nacional de Energia Elétrica (ANEEL), SIGEL, 2020

Termoverde Caieiras, a member of The Solví Group, is the largest thermoelectric power plant in Brazil powered by gas from landfill (AGÊNCIA BRASIL, 2020). The São João landfill thermoelectric power plant generates electricity from the gas produced by the natural decomposition of solid residue deposited in the São João landfill. In Nova Iguaçu, state of Rio de Janeiro, the plant generates electricity from biogas produced by the decomposition of waste at the Waste Treatment Center (CTR) in Adrianópolis, Nova Iguaçu. The plant has a total capacity to generate around 16.5 MW (PREFEITURA NOVA IGUAÇU, 2020). Asja Market is an Italian subsidiary accredited to sell green energy at the Italian Power Exchange and worldwide. Asja's **launched in 2019 a new biogas-to-energy** with an installed capacity of **14 MW (**ASJA ENERGY, 2020)**.**

5 CONCLUSION

Most governments around the world are aware of the importance of increasing and improving the participation of renewable energy sources to produce electricity in the energy matrix, mainly due to environmental concerns.

Brazil has played an important role on the electricity production by renewables mainly due to their hydropower generation dominant system associated to wind, solar and biomass energy sources.

Sugarcane is the most important biomass for electricity generation in Brazil followed by black liquor.

Sugarcane production is carried out throughout the national territory, but the production remains mostly concentrated in the Southeastern region and most of the plants are self-sufficient in electricity. The electricity surplus is sold to the national grid and is important to point out that several sugarcane plants in Brazil are self-sufficient regarding electric energy.

The production of black liquor is concentrated in pulp production regions, especially in the Paraná and Mato Grosso do Sul States. The units generate electricity surplus available to the national grid.

Wind turbines and photovoltaic panels will increasingly coexist with hydro sources as future trends for the Electrical Sector in Brazil. The bioelectricity generated from sugarcane will also maintain a significant share in the energy matrix. Until the appearance of COVID-19, a considerable growth in electricity consumption was expected for Brazil in the upcoming years. Despite the reduction in consumption caused by the pandemic, it is still necessary to strike a balance among renewable sources to guarantee electricity supply.

The main contribution of this work is presenting the production of electricity in Brazil by mapping the main sources of biomass used in the country.

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