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RESEARCH ARTICLE OPEN ACCESS

DISTRIBUTED GENERATION ASSET LEASE MODEL FOR PUBLIC ADMINISTRATION

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ABSTRACT

In 2021, according to Portal Solar, distributed generation reached the sum of 6.9 GW of operational capacity, with a growth projection of around 31.25%. According to Absolar (Brazilian Association Photovoltaic Solar Energy), point out that even with the pandemic, solar energy generation in Brazil reached a capacity of 7GW, with more than 4GW of distributed generation. This growth is due to consumers' search for projects and actions that can reduce electricity costs. Electricity bills were the biggest person in the disclosure of official inflation in the last 12 months (2020-2021) and consumers, both individuals and companies, felt the impact of this expense, especially in the period of water scarcity, with the activation of the thermoelectric plants generating the tariff flag. Solutions to reduce electricity costs include the implementation of solar plant projects in homes and businesses, as well as large plants in the remote self-consumption or shared generation model, based on ANELL resolution nº 482/2012. The objective of this article is to describe the asset leasing model of the distributed generation system and its applicability in a public financial institution and its respective results.

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INTRODUCTION

This new digital world, as well as any activity whether commercial, services or in industry, as well as in our homes, nothing works without electricity. This input has become vital for any sector of the economy, especially in financial activities. With the increase in electricity consumption across the planet, new ways are being studied to simultaneously produce more electricity and reduce waste with efficient systems and equipment (IEA, 2020). Electricity consumption has increased worldwide in recent decades, and in 2018 alone, world consumption increased by 2.3%, both because new technologies and means of production are increasingly less dependent on fossil fuels and have as source of energy and electricity, as well as the increase in world population and consumption within homes (BRAZIL, 2019). Over the next ten years, Brazil's total energy demand is expected to grow 5.3% per year, reaching 372 million in 2030. Industry and the transport sector should continue to be the main responsible for a large share of this consumption, with about 67% of the total. In 2019, the energy crisis affected most countries in the world, boosted by the new coronavirus pandemic, leading the sector to seek alternatives to avoid losses that could harm operations, and, consequently, the final consumer. In the worst phase of the COVID 19 pandemic in 2020, Brazil went through a long period of consumption retraction, to protect the sector, the federal government created Conta-covi, a measure to support electricity distributors in addition to resources released by the Government, via BNDES, which totaled around R$ 16 billion. The Ten Year Energy Expansion Plan (PDE 2030), developed by EPE, points to a 48% share of renewable sources in the energy matrix in 2020, maintaining this level in 2030. In the electricity sector, the 2020 supply was 85% of renewable sources and, despite the virtuous growth necessary to meet the demand, it is expected to reach the level of 85% by the end of the decade. It is still too early to measure the real impacts on the Brazilian economy and energy sector. One of the solutions for the energy crisis and for reducing energy bill expenses involves investments in renewable energy sources capable of bringing greater diversification to the Brazilian energy matrix. Since the publication of ANEEL Normative Resolution No. 482/2012, Brazilian consumers can generate their own electricity from renewable sources or qualified cogeneration and even supply the surplus to their local distribution network. In this model, the solar energy source showed high growth in recent years, according to Absolar, the photovoltaic source in centralized and distributed generation accumulated 270 MW of installed power in the first months of 2021, after closing in 2020 with 7,740 MW of generation solar energy, the sector reached the 8,010 MW mark at the end of February, according to the Absolar infographic. The high

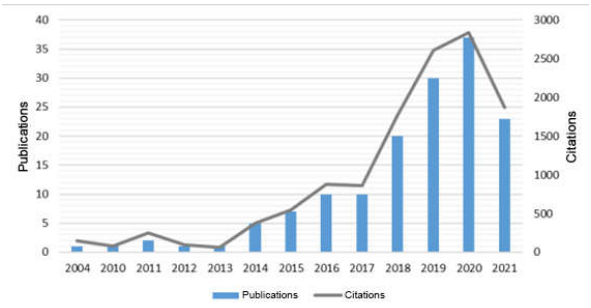
consumption of electric energy in the public administration led several bodies to seek alternatives to reduce expenses, one of them was the implementation of photovoltaic panels in administrative buildings in the off-grid model (not connected to the distribution network) or on-grid (connected to the distribution network). In the on-grid model, there is distributed generation created by REN nº 482/2012. Despite all the expansion of the use of energy from renewable sources by the public administration, the number is still small compared to the volume of energy consumed. One of the factors that influence the non-use of this technology is that the administration bodies tend to build the plants with their own investment, impacting the budget, in addition to the plant's delivery time. The public financial institution, object of the study, developed a project in which the institution did not allocate any financial resources in the construction of the plants and has already had significant gains in the reduction of electric energy expenses, in addition to environmental and image gains. The objective of this article is to describe the asset leasing model for renewable energy generation and the results achieved in the period of 2 years after the project implementation.

METHODOLOGY

This is a case study, with a qualitative approach to data and a confirmatory objective with the presentation of the results. The case study took place in a public financial institution, with the bidding process, with the lease of two photovoltaic generating plants, creating the inauguration of two solar plants, by distributed generation, in the remote self-consumption model, in the state of Minas Gerais and Pará. According to Clemente Jr (2021), the case study is an empirical investigation that investigates a contemporary phenomenon in its real-life context, even if the limits between the phenomenon studied and the context are clearly defined. To verify the relevance of the subject of this article, a bibliometric research was carried out on the subject in Brazil.

BIBLIOMETRIC ANALYSIS

In order to validate the relevance of the topic in this article, a bibliometric research was carried out on the topic addressed. As described by SOARES, P.B. et al (2016, p.176), bibliometric analysis brings quantitative indicators that measure the contribution of scientific knowledge derived from other works and publications at a given time. The "Web of Sciente" (WoS) platform was used to carry out the research, as it has a more intuitive interface and analyzes the results on the platform itself. In the research, the following algorithms (filters) were determined: "Engineering Electrical Electronic", "Energy Fuels", "Environmental Sciences", "Environmental Studies", "Economics", "Green Sustainable Science Technology", including all fields, mentions in topics, titles and affiliations among others.



Source: Own elaboration based on data from Web of Science (2021)

Figure 1. Historical series of publications regarding generation by photovoltaic plant

These terms were used since we did not find an expression in English for "distributed generation". Finally, no limiting filter was added to the type of document, in order to verify their relevance through the citations. The first result obtained in the concept of energy generation by solar plant for own consumption. However, as mentioned, the difficulty of finding entries for "distributed generation", "self-producer", indispensable for bibliographic analysis. When using "self-production" and "self-producer", few results were obtained. Thus, it was necessary to include the broader concept of own production: "Photovoltaic (All Fields) AND Generation (All Fields) AND Renewable Energy (All Fields) AND Consumption (All Fields) AND Solar (All Fields)" presented a total of 707 associated works. Figure 1 shows the number of publications per year, as well as the volume of citations. Brazil appears in the ranking of regions in tenth position in number of published works, with 26 publications, as shown in Table 1.

Table 1. Most cited documents in the survey

Author	Title	Year	Cited by
Rabaia, MKH; Abdelkareem, MA; Sayed, ET; Elsaid, K; Chae, KJ; Wilberforce, T; Olabi, AG	Environmental impacts of solar energy systems: A review	2021	285
Sansaniwal, SK; Sharma, V; Mathur, J	Energy and exergy analyses of various typical solar energy applications: A comprehensive review	2018	282
Giwa, A; Alabi, A; Yusuf, A; Olukan, T	A comprehensive review on biomass and solar energy for sustainable energy generation in Nigeria	2017	217
Cuce, E; Harjunowibowo, D; Cuce, PM	Renewable and sustainable energy saving strategies for greenhouse systems: A comprehensive review	2016	201
Lian, JJ; Zhang, YS; Ma, C; Yang, Y; Chaima, E	A review on recent sizing methodologies of hybrid renewable energy systems	2019	193

Source: own elaboration

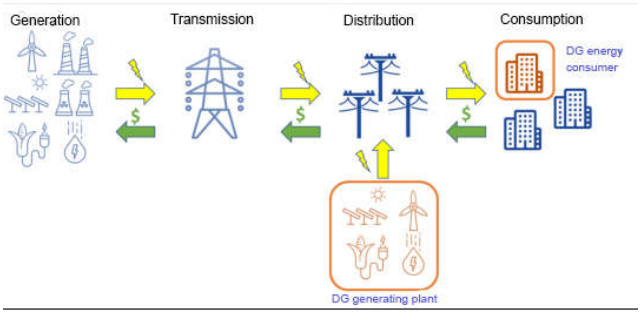
Figure 2. Brazilian energy matrix

SPECIFICATION	GWh		20/19 %	Structure (%)	
	2019	2020		2019	2020
HYDRAULICS	397.877	396.327	-0,4	61,1	61,4
SUGARCANE BAGASSE	36.827	38.776	5,3	5,7	6,0
WIND POWER	55.986	57.051	1,9	8,6	8,8
SOLAR	6.655	10.750	61,5	1,0	1,7
OTHER RENEWABLES (a)	18.094	19.966	10,3	2,8	3,1
OIL	6.926	7.745	11,8	1,1	1,2
NATURAL GAS	60.448	53.464	-11,6	9,3	8,3
COAL	15.327	11.946	-22,1	2,4	1,8
NUCLEAR	16.129	14.053	-12,9	2,5	2,2
OTHER NON RENEWABLE (b)	12.060	11.121	-7,8	1,9	1,7
IMPORT	24.957	24.718	-1,0	3,8	3,8
TOTAL (c)	**651.285**	**645.915**	**-0,8**	**100,0**	**100,0**
of which renewable	*540.395*	*547.587*	*1,3*	*83,0*	*84,8*

Source: Brazilian Energy Review – 2020 Results

DISCUSSION

Distributed Generation in Brazil: The energy supply crisis experienced by the country in 20211 created two energy trading environments: the Regulated Contracting Environment (ACR), where concessionaires have a monopoly on energy supply in their concession area, and the Contracting Free Environment (ACL), which allows the customer to purchase energy directly from generators, maintaining a strategy of expanding the supply of renewable energies and promoting a low-carbon economy. With the creation of these two models, there was an increase in the availability of electricity from renewable sources. Figure 1 presents the matrix. In 2020, renewable sources had an 84.8% share in the domestic electricity supply matrix (OIEE), an indicator 1.8 percentage points higher than in 2019, Wind and sugarcane bagasse generation, highest in second semester of each year, is complementary to the seasonality of hydraulic generation. Solar energy has already surpassed oil generation (diesel and fuel oil). In the case of bagasse, of the 38.8TWh generated, 22.7TWh were surpluses for the market and 16.1 TWh for own consumption. It is also worth mentioning the 10.3% increase in generation from "other renewables", with biogas rising by 15.7% (from 1,148 GWh in 2019 to 1,329 GWh in 2020. One of the factors that led to the growth of the use of solar energy was the model of distributed generation. In 2012, with the publication of Normative Resolution No. 482 of ANEEL, later revised with Resolution No. 687 of 2015, which allowed consumers classified under the ACR to access mining and distributed microgeneration of energy and the compensation system.



Source: Prepared by the authors adapted from ANEEL

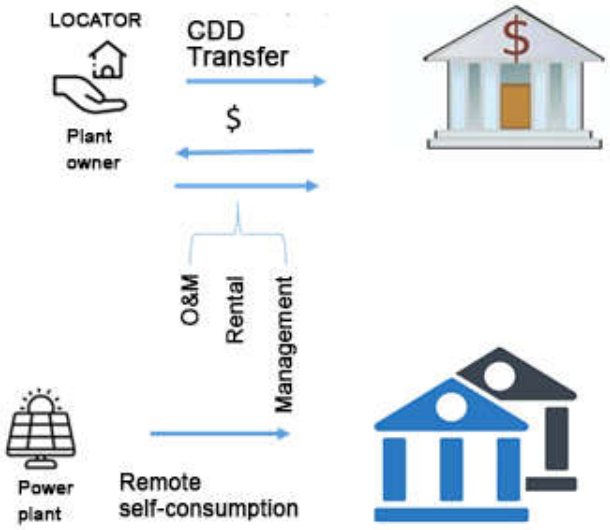
Figure 3. Energy flow and payments for distributed generation

The mini-power generation system allows the energy consumer to connect to the distribution network of the central concessionaires energy generators in a range of up to 3 MW for hydro sources and 5 MW for other sources. Through the energy compensation system, the consumer can compensate consumption with energy generation, through the instrument called net-metering or "free loan of generated active energy", with subsequent compensation of consumption also by active energy (ANEEL, 2015). This system is based on a mechanism for generating active energy credits that can be used within up to 60 months after billing, being absorbed by the utility if not used ((BRADSHAW, 2017; ROSAS LUNA et al., 2019; VILAÇA GOMES et al., 2018). According to Vilaça Gomes (2018), this arrangement eliminates some barriers to the integration of small generation systems into the National Interconnected System (SIN), in addition to encouraging the search for consumers inserted in this context for this modality, given that there are instruments for exploitation and benefits to the the country's electrical system in a comprehensive manner, such as the postponement of investments in the expansion of generation, transmission and distribution systems; reduction of environmental impacts associated with large works of plants, reduction of energy demand; reduction of transmission losses and matrix diversification. Brazil ended 2020 with an installed capacity of 174,412.6 MW of supervised power, according to data from the ANEEL Generation Information System (SIGA), of this total in operation, 74.76% of the plants are driven by sources considered sustainable, with low emission of greenhouse gases.

According to the Brazilian Association of Distributed Generation (ABGD) until August/2021, DG reached 581,274 connections in Brazil, with 6,682.14 MW of installed capacity of photovoltaic energy alone. This model, as demonstrated by the authors, remains expanding due to the incentive policies that the opters benefit financially and that such incentives should even be improved for the continuity of their expansion (FARIA JR; TRIGOSO; CAVALCANTI, 2017; ROSAS LUNA et al., 2019; VILAÇA GOMES et al., 2018). On the other hand, energy concessionaires exert a force against access to customer connections, who opt for the distributed generation model, through delays in connecting generating units to the grid. In this scenario, there are still consumers who do not generate their own energy, the Concessionaires and some political fronts claim that these consumers pay the bill for the use of the wire of all consumers who generate their own energy through distributed generation. According to the Brazilian Association of Electric Energy Distributors (Abradee), subsidies for distributed generation of electricity, including solar, represent an extra cost for all Brazilian consumers of R$ 1 billion per year. In August/2021, the Chamber of Deputies approved the bill 5829/19, according to the text, consumers who already have a distributed generation system will remain exempt from charges until 2045. Anyone who requests entry into the system up to 12 months after the publication of the new legislation will also be exempt until 2045. For new consumers there will be a transition rule. The proposal is that consumers start paying 15% of the costs associated with electricity in 2023, where the percentage will gradually increase. The project provides for a transition in the payment of charges related to the remuneration of the distribution service assets, the depreciation of network equipment and the cost of operation and maintenance of the service. The difference will be covered by funds transferred to energy distributors through the Energy Development Account (CDE). Even in the face of this scenario, added to the period of the Coronavirus pandemic, there was a rush to implement this model in Brazil.

THE CASE OF THE PUBLIC FINANCIAL INSTITUTION

The institution published its first public notice in 2018 with an unprecedented object in the public administration of leasing a distributed generation system (SGD), for mini-generation of electrical energy from a photovoltaic source for the production of at least 10,000 MWh/year in Minas Gerais. The second public notice published in 2019, in the same model, provides for the generation of at least 2,000 MWh/year in the state of Pará. The content of this public notice originated from a technical study started in 2017, based on data on consumption and expenditure on electricity from low voltage facilities, totaling 3,590, representing 40% of the total paid by the institution in electricity. The leasing model for distributed generation has the characteristic of being a project built specifically with the objective of guaranteeing a reduction in the electric energy bill. This format is similar to “built to suit” where the development is built specifically for the needs of its future tenant. The plant is built by the investor, bearing all the financial costs and the institution has committed to the lease for 15 years. The company was also responsible for the maintenance of the plant.



Source: own elaboration

Figure 4. Lease model for distributed generation by remote self-consumption

In this model, the amount paid (CAPEX) of the generation asset belongs to the investor, including the request for an access opinion to connect the plant to the distribution network and expenses with investments in the network, if necessary. In addition to the investment, the company is also responsible for the maintenance of the plants. The land must be owned by the investor and ownership was transferred by the institution through a free-use assignment agreement. After connecting the plant to the distribution network, the contract for the use of the distribution system (CUSD) is transferred to the institution. The model used was the offsetting of credits in remote self-consumption. At DG, the consumer unit, after discounting its consumption, receives an account credit for the energy generated and inserted into the concessionaire's network (energy compensation system). Whenever there is a positive balance, the consumer unit receives the energy credit (kWh, for example) and can use it for a period of 60 months. The energy generated by the two plants was injected into the grid and will compensate the consumption of 139 branches in MG and 35 in Pará, reaching 100% of abatement for energy consumption, remaining expenses with the minimum rates of consumption, public lighting and other taxes. These dependencies can be replaced, as long as they are in the same energy distributor.

The institution decided to install its first plant in the state of MG and chose the photovoltaic source because of:

- Solar incidence of 5.5 to 6.5 kWh/m²/day in more than half of the State's area, more precisely, it comprises a vast region west of MG;
- The north of MG received the largest number of installed photovoltaic DGs, 800 connections made; already consolidated business model;
- The wind potential is approximately 40GW in the TriânguloMineiro, North and Northeast regions. Despite the potential, there are few investors for this type of technology, due to the high costs of installation and maintenance. The Northeast and South are the regions most prone to this type of source;
- Although MG has the largest number of PCHs installed in the country, 102 projects, with a generation capacity of 600 thousand KW of energy, this type of source was disregarded due to environmental risks;
- Tax incentives;
- Few investments in biomass, due to the absence of state government investments and incentives;
- Replacement of the tariff of R$707.00/MWh paid to the concessionaire (Cemig) for a cost of R$445.00/MWh equivalent to the lease of the solar plant and distribution of the generated energy. (base year 2018);
- Approximate savings of 32% for the period of 15 years.

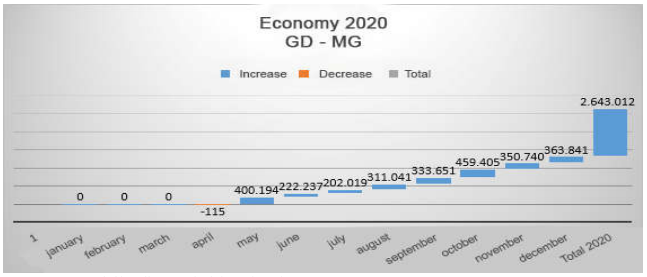
To support the formation of the budget, the institution requested proposals from suppliers, containing:

- Brief description of the company, its main customers, activities and amount of electricity in its portfolio;
- Preliminary study of estimated savings for each of the 58 consumer units (in BRL and % reduction) in the 15-year period (2018-2022); with the possibility of renewal for another 10 years;
- Monthly breakdown of branch consumption and own generation;
- Estimated price of the monthly lease cost and per kWp/month;
- Inclusion of the costs of operation, maintenance, replacement of equipment, supplies, cleaning, surveillance, and the cost of managing the solar condominium;
- Indicator usually used to correct tariffs over the contractual term.

Due to the costs of installing and maintaining the solar plant, the model became viable for the supplier within a minimum period of 10 years. Therefore, the scaling of costs for 15 years of contracting was considered favorable. The winning proposal of the first public notice was worth R$ 44 million, the second plant was worth R$ 10,440,000.00 for the state of Pará, according to information from the bidding-e portal, with a projected savings for the MG in 58% and for the PA in 35%.

RESULTS

To demonstrate the results with the leasing of the plants, a method of comparing the total invoices of the selected dependencies without using the plant with the total invoices with solar plants was used. The MG plant started operating in March/2020 and benefited 139 facilities with 100% compensation for electricity consumption. From the inauguration of the MG plant until March/2022, the use of DG brought savings of R$7,332,607.84. For the Pará plant, 35 branches were benefited, generating savings of R$288,481.40, as shown in figures 8 and 9: In January and November 2021 and January/2022 there were no savings, because the plant was inoperative due to technical problems. In the public notice, specific rules were created for payment according to the power generation performance by the plant. The observed economy suffered important impacts due to the reduction in the load of the agencies during the COVID-19 pandemic. However, despite the reduction in the consumption load, in the DG environment, generation credits can be used within a period of up to 60 (sixty) months.

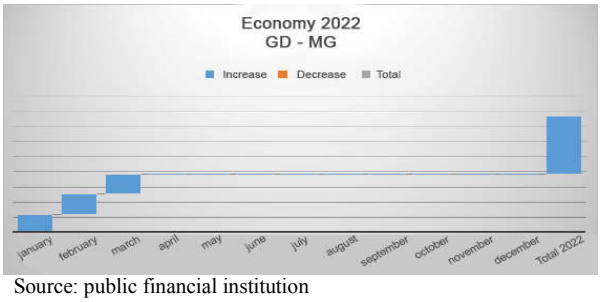


Source: public financial institution

Figure 5. Economy 2020 - MG Plant

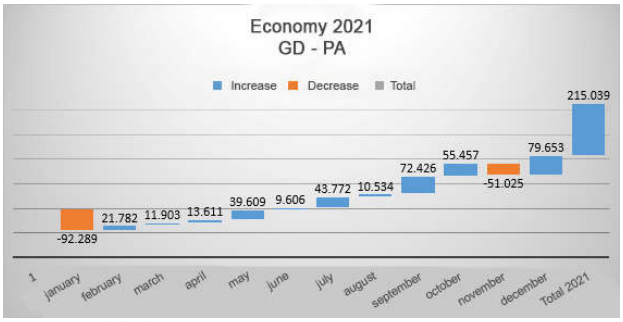
Source: public financial institution

Figure 6. Economy 2021 - MG Plant



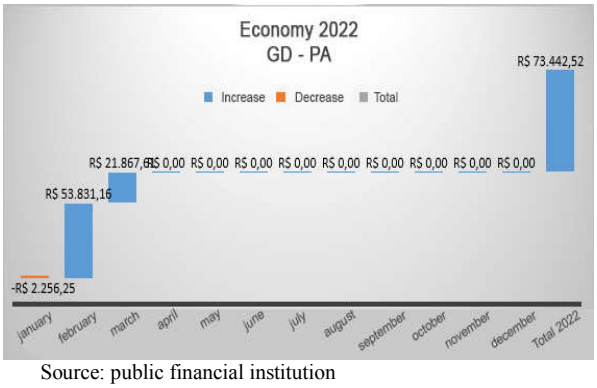
Source: public financial institution

Figure 7. Economy 2022 - MG Plant



Source: public financial institution

Figure 8. Economy 2022 - PA Plant



Source: public financial institution

Figure 9. Economy 2022 - PA Plant

These credits can even be used in units connected to both Low and Medium Voltage commercial, thus enhancing the projected financial return. In addition to the financial gains, the public notice established the obligation for the winning companies to implement a social project in the region, in MG a community day care center of the city hall won the installation of a micro plant, as well as the municipality's health post in PA.

CONCLUSION

The results demonstrate that the model used for leasing the plants brought financial, environmental and social gains. The savings obtained by replacing a high tariff (expenditure on energy bills without DG) for a lower expense (plant lease) was significant, reducing the institution's budget with electricity. The use of renewable energy reduces the ecological footprint, contributes to a cleaner Brazilian energy matrix and reduces greenhouse gas emissions, generating credits (energy certificates) that can be used to offset FI emissions. It had direct gains for society, with job creation and implementation of social projects in the community.

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