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SOLAR ENERGY, AN ALTERNATIVE FOR COST REDUCTION IN SHOPS AND INDUSTRY IN BRAZIL

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ABSTRACT

Solar energy is an increasingly popular option in cities and in the countryside, as it is a clean, renewable source of energy that can generate significant savings on the electricity bill. Installing solar energy in businesses and small industries is a relatively simple process and can be carried out by specialized professionals. By opting for solar energy, businesses not only save money, but also contribute to a more sustainable world, reducing greenhouse gas emissions and preserving natural resources. It is important to remember that it is necessary to choose a suitable company to make a correct assessment of the location and energy consumption to ensure efficiency. The feasibility of installing solar energy in a small bakery was studied in order to deepen the analysis of technical feasibility, feasibility of physical space, financial feasibility, payback time, during the development of the work visits were made to the structure of the BAKERY As part of the study, a survey was carried out of the equipment installed in the bakery and the current energy consumption and the cost of this energy were also verified, thus evaluating the location where the photovoltaic panels will be installed.

I. INTRODUCTION

Solar energy is the generation of electrical energy from the capture of solar radiation through solar panels installed on site for the generation of thermal and electrical energy [1]. This energy is then sent to the grid and can be used to power electrical appliances. The photovoltaic energy scenario in Brazil has shown significant growth in recent years [2-4]. According to the Ministry of Mines and Energy (2020), the country registered a significant increase in installed solar energy capacity, reaching around 10 gigawatts (GW) in 2020. This expansion is a result of both the abundant solar potential and government policies favorable.

According to [5], Brazil has enormous potential for solar energy due to its privileged geographic location. The country receives high average solar irradiation, approximately 2200 kWh/m² per year, making it one of the best places for solar power generation in the world. In addition, the predominantly tropical climate favors the maximum use of solar radiation.

Government policies have played a key role in the development of photovoltaics in Brazil. The Distributed Electricity Generation Development Program (ProGD), launched in 2015, has encouraged the adoption of renewable sources, including solar. This initiative has contributed to the diversification of the Brazilian energy matrix and to the reduction of dependence on non-renewable sources [6].

The reduction in the costs of photovoltaic technology has also driven the sector's growth. The drop in prices of solar panels, combined with the increase in the efficiency of photovoltaic systems, has made solar energy an increasingly competitive option compared to conventional energy sources [5]. This factor has aroused the interest of investors and entrepreneurs, resulting in a significant increase in the number of solar projects across the country.

Despite promising growth, photovoltaic energy in Brazil still faces significant challenges. One of the main obstacles is the lack of transmission infrastructure for the flow of energy generated in isolated regions [7]. The expansion of the transmission network

is essential to enable the efficient integration of solar systems into the national electricity matrix.

To overcome these challenges, it is essential to continue investing in research, development and implementation of solar projects in the country. Promoting tax incentives and improving transmission infrastructure are necessary measures to further boost the growth of photovoltaic energy in Brazil [7-10].

II. THEORETICAL REFERENCE

The increase in the energy source through photovoltaic panels shows a very high and perceptive growth trend over the years. In 2018, in an unprecedented way, 100 GW were installed globally in the same year, which is something great and which shows the potential of solar energy in the world as a whole, not just in one region, the growth took place from of 1.2 GW in the year 2000. According to [11] in 2007 there were 9.2 GW of solar photovoltaic plants, in 2018 this capacity had already been increased to 505 GW, or that is, a surprising exponential growth, which exceeded 42,000%.

From an environmental point of view, photovoltaic energy generation offers several benefits, which, together with savings in energy bills, become one of the main renewable sources to be used in the coming years. In addition, it is an inexhaustible and free source, which is available for the vast majority of habitable places on the planet, with Brazil being one of the main optimal countries for the installation of solar panels [12].

Exploiting the sun's rays does not imply scarcity of resources, does not produce liquid or solid waste or significant environmental damage over time. During the operation of the photovoltaic systems, there are no GHG emissions or any polluting substances that may harm the environment or human beings. These characteristics mean that the generation of energy through solar panels can be installed not only in large plants, but also in small businesses or even in homes, since it does not offer harm to health or well-being; on the contrary, it can benefit it, since it is replacing another source of energy that harms the environment and may even pollute. Therefore, the decrease in pollution can reduce the incidence or worsening of several chronic diseases, such as those of the respiratory system and the heart, etc. [13-14].

Figure 1 presents an overview of the energy matrix in Brazil in the years 2020 and 2021, in this overview it is possible to verify that the source of solar energy was the one that grew the most in proportion, having reached more than 55.9% of growth, while wind had an increase of more than 26.7%, natural gas a little more than 46.2% and coal more than 47.2%. This panorama was largely due to the rainfall in 2021, which directly affected the production of energy through hydroelectric plants in Brazil, thus other renewable sources had their growth accelerated in this period [15].

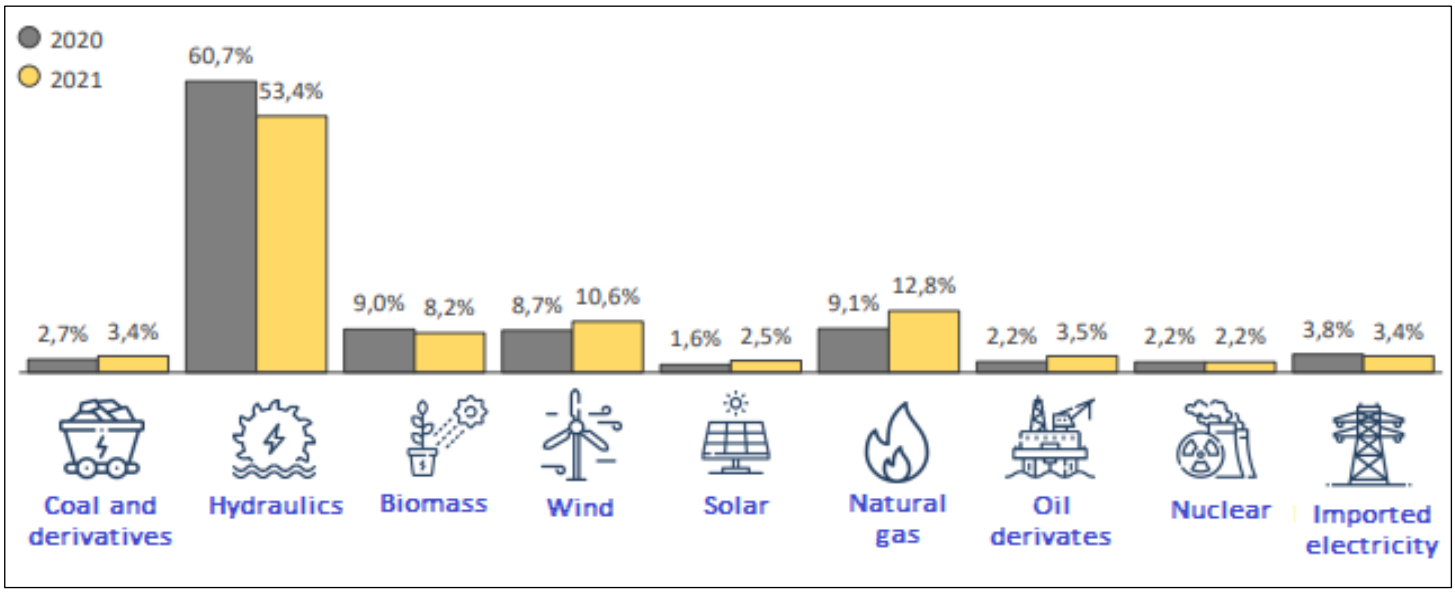

Figure 1: Energy matrix in the years 2020 and 2021.
Source: [15].

II.1 ADVANTAGES AND BENEFITS OF SOLAR ENERGY

According to [10], solar energy for bakery has many advantages and benefits, such as:

- Be a clean and renewable source of energy;
- Generates significant savings on the electricity bill;
- It is a positive reinforcement of the brand that cares about the environment;
- Allows greater energy independence;

According to [16] solar energy also contributes to the reduction of the carbon footprint, having a high potential for replacing hydroelectric and thermoelectric plants.

II.2 BAKERY SOLAR ENERGY INSTALLATION

Installing solar energy in a bakery is a relatively simple process that can be carried out by specialized professionals. The responsible company must have trained professionals, good quality panels and inverters and have its own teams for each stage of the project, such as planning, engineering and installation. In addition, the solar energy company must carry out an analysis of the installation site, to verify inclinations, a [17] orientation in relation to the sun, possible shading and if the bakery has enough space to install the panels. It is also necessary to make an assessment of the current energy consumption and the intended consumption after installation, in order to correctly dimension the project.

II.3 HOW SOLAR ENERGY CONTRIBUTES TO A MORE SUSTAINABLE WORLD

Solar energy contributes to a more sustainable world in many ways, including:

Reduction in the emission of greenhouse gases: generating electricity from solar energy does not emit greenhouse gases, which helps reduce carbon emissions and contributes to the fight against climate change; According to [18], the generation process, which is performed by a semiconductor device, does not produce waste, does not release residual heat and does not alter the balance of the environment, being considered sustainable.

Preservation of natural resources: solar energy is a renewable energy source, which means that it does not deplete natural resources like fossil fuels; Energy independence: the generation of electricity from renewable sources, such as solar energy, helps businesses to become independent from traditional energy sources [16].

Photovoltaic energy in Brazil shows the solar potential it has due to the country's ability to deploy and invest in clean, renewable energy and not in scarce energy, thus being able to reach the level of countries that are a reference when it comes to solar energy such as Germany, Italy, United States, Japan and China [19].

Within this context, on photovoltaic solar energy, the objective is to analyze the economic viability of the implementation, efficiency in replacing conventional electrical energy, in addition to addressing technical issues and an overview of this technology installed in a small bakery in the Manaus region.

III. MATERIALS AND METHODS

Table 1 shows the materials used in the installation of solar panels, the main ones being the photovoltaic module (solar plates), inverters, male and female connectors, solar cable and protection frame, this is a kit that was necessary for the implantation of the plates. solar.

Table 1: Materials used to implement the system with photovoltaic panels.

Photovoltaic Module		**Inverter 9.1 Kw,3MPPTSC/ WIFI**	
Manufacturer:	**Leapton**	Manufacturer:	solplanet
Power:	**665 Wp**	Power:	9100 w
Warranty (defects)	**10 years**	Warranty (defects)	10 years
Guarantee (efficiency):	**25 years**	monitoring	wifi
Amount:	**40**	Amount:	1
Inverter 7.3 Kw,3MPPTS, C/ WIFI		**Additional Equipment**	
Manufacturer:	solplasnet	Protection frame set	
Power:	7300w	AO CC (1E/1S + 2X 2E/2S)	
Warranty (defects)	10 years	Manufacturer:	So Energy
monitoring	wifi	Amount:	1
Amount:	1		
Additional Equipment		**Additional Equipment**	
Pair of MC4 1500V connectors (Male+Female)		Black Solar Cable 6mm	
Manufacturer:	SOU ENERGY	Manufacturer:	So Energy
Amount:	24	Amount:	120 m
Additional Equipment		**Additional Equipment**	
Red Solar Cable 6mm		Slab/soil KIT for 14 modules	
Manufacturer:	So Energy	Leapton 665 in Portrait-Solar Group	
Amount:	120 m	Amount:	2
Additional Equipment		**Additional Equipment**	
Mini rail 27.5 cm for fiber cement roof		AC Component KIT for three-phase	
(for thirds of wood with spacing)		220V (S11-B63-220v)	
between 1.3 m and 1.8 m)		Amount:	1
Amount:	12		
Manufacturer:	So Energy		

Source: Authors, (2023).

IV. RESULTS

IV.1 COST OF INSTALLATION

In this topic, the estimated financial aspects of the project and installation will be described, such as: Savings generated, prices, payment methods and analysis of financial viability.

Table 2 shows the cost with and without the system, without the system the monthly expenditure on energy is R$ 2,525.00, while with the photovoltaic panel system, the value drops dramatically to R$ 201.86 per month, generating savings of R$ 2323.14 per month, showing that the value of savings is very high and that the investment in a solar system is worth it.

Continuing the comparison in Table 2, another data that proves to be relevant is the estimated savings for the year, which is close to R$ 27,877.69, this value in the long, medium and long term is quite satisfactory for small businesses such as the bakery studied.

Table 2: Application costs.

Item description	Amounts in reais (R$)
Account cost without system	2.525 R$/month
System account cost	201.86 R$/month
Estimated cost of first year without system	30,300.00 R$/Year
Estimated cost of the first year with the system	2,422.31 R$/year
Estimated average monthly savings in the first year	2,323.14 R$/month
Estimated total savings in the first year	27,877.69 R$/month

Source: Authors, (2023).

IV.1.1 Feasibility Indicators

Table 3 shows the advantages of applying solar panels in homes and small businesses, it also shows percentages and values of the project carried out. It is worth noting that the study was based on a small bakery, but the feasibility of installing solar panels is also valid for other bakeries and local businesses that, with the high amount of energy consumed, become a point to be explored by small entrepreneurs in the city of Manaus, which have medium and long-term returns.

Table 3: Advantages of the application.

Application advantages	Values and deadlines
System value without financing	BRL 89,954.12
Annual energy readjustment	10% average
Payback (turnaround time)	2 years and 10 months
Roi (return on investment)	28.72 times
Tir (Internal Rate of Return Investment)	40.93%
Value kwh System	0.14R$/kwh (0.84 savings per hour)
Economy in 25 years	BRL 2,583,452.78

Source: Authors, (2023).

Table 3 shows that the value of the cost for the implementation of photovoltaic panels in the bakery has a relatively high cost, but it has a skillful and satisfactory payback time, considering that photovoltaic panels last on average about 25 years if well cared for , having a payback of 2 and a half years, means that the bakery owner would have about 22 years of low energy costs, the biggest expense being with maintenance and cleaning of the plates, which is a considerably low cost, thus being feasible have solar panels.

And the most striking data is the savings that would be achieved in 25 years, which would be approximately R$ 2,583,452.78, which is a high amount, this economy is due to the fact that Brazil is an excellent country to have a of photovoltaic panels, since the climatic conditions are propitious for this purpose.

This article seeks to show in a simple way that the use of photovoltaic panels for the consumption of renewable energy is valid in Brazil and that the financial return in savings with the energy bill is quite satisfactory, despite some difficulties such as the capital for the implementation of the system and the lack of some laws that encourage the implementation of this system, the use of photovoltaic panels is still quite valid.

V. CONCLUSIONS

Solar energy in Brazil has experienced significant growth, driven by factors such as abundant solar potential, favorable government policies and lower technology costs. Although there are challenges to be overcome, such as energy transmission and storage infrastructure, the future of solar energy in Brazil looks promising. With continuous investments in research, development and implementation of solar projects, the country can take full advantage of its solar potential, contributing to the diversification of the energy matrix and environmental sustainability.

V. AUTHOR'S CONTRIBUTION

Conceptualization: Antônio Rodrigues de Oliveira.
Methodology: Antônio Rodrigues de Oliveira.
Investigation: Antônio Rodrigues de Oliveira and Paulo Francisco da Silva Ribeiro.
Discussion of results: Antônio Rodrigues de Oliveira and Paulo Francisco da Silva Ribeiro.
Writing – Original Draft: Antônio Rodrigues de Oliveira.
Writing – Review and Editing: Paulo Francisco da Silva Ribeiro.

Resources: Antônio Rodrigues de Oliveira.
Supervision: Paulo Francisco da Silva Ribeiro.
Approval of the final text: Antônio Rodrigues de Oliveira and Paulo Francisco da Silva Ribeiro.

VI. REFERENCES

[1] RUTHER, R. Edificios solares fotovoltaicos: o potencial da geração solar fotovoltaica integrada a edificações urbanas e interligada à rede elétrica pública no Brasil. LABSOLAR. Florianopólis, 114p, 2004.

[2] Santana, L. V. R., Stosic, T., Ferreira, T. A. E., & da Silva, A. S. A. (2020). Análise da regularidade da velocidade do vento no Nordeste do Brasil através da Sample Entropy. Research, Society and Development, 9(7), e762974746-e762974746.

[3] Barbosa de Alencar, D., de Mattos Affonso, C., Limão de Oliveira, R. C., Moya Rodriguez, J. L., Leite, J. C., & Reston Filho, J. C. (2017). Different models for forecasting wind power generation: Case study. Energies, 10(12), 1976.

[4] Parente, R. S., Alencar, D., Junior, P., Silva, I., & Leite, J. (2021). Application OF the narx model for forecasting wind speed for wind energy generation. International Journal of Development Research, 11(4), 46461-46466.

[5] Silva, J. R., & Oliveira, J. L. M. (2019). Energia solar no Brasil: análise do mercado fotovoltaico e potencial para o crescimento. Revista Brasileira de Energias Renováveis, 8(2), 224-240.

[6] Ministério de Minas e Energia. (2020). Boletim mensal de energia solar fotovoltaica no Brasil.

[7] Soares, F. S., & Costa, F. J. (2018). A expansão da energia solar no Brasil: potencialidades e desafios. Revista de Política Agrícola, 27(3), 38-48.

[8] Rella, R. (2017). Energia fotovoltaica no brasil. Revista de Iniciação Científica, 15(1), 28-38.

[9] SHADE, P. (2018). Análise da viabilidade para implantação de energia fotovoltaica com utilização para sombreamento de estacionamento. Revista do CEPE. Santa Cruz do Sul, (47), 36-48.

[10] CARSTENS, D. D. S.; CUNHA, S. K. Challengesandopportunities for thegrowthof solar photovoltaicenergy in Brazil. Energy Policy. 125, 396-404, 2019.

[11] Pereira, M., & OLIVEIRA, M. C. T. I. D. (2011). Energía solar fotovoltaica.

[12] Avelino, L. P. (2020). Energia Solar Fotovoltaica Centralizada e Distribuída: o Caso do Brasil.

[13] Hosenuzzaman, M., Rahim, N.A., Selvaraj, J., Hasanuzzaman, M., Malek, A.B.M.A., & Nahar, A. (2015). Global prospects, progress, policies, and environmental impact of solar photovoltaic power generation. Renewable and Sustainable Energy Reviews, 41, 284–297. https://doi.org/10.1016/j.rser.2014.08.046

[14] International Energy Agency. (2019). Global Energy & CO2 Status Report - The latest trends in energy and emissions in 2018. Retirado do https://webstore.iea.org/global-energy-co2-status-report-2018

[15] Empresa de Pesquisa Energética (EPE), 2022. Acessado em: 22/04/2023. Disponível em: https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-675/topico-631/BEN_S%C3%ADntese_2022_PT.pdf

[16] KONZEN, G. Difusão de sistemas fotovoltaicos residenciais conectados à rede no Brasil: uma simulação via modelo de Bass. Tese de dissertação de mestrado. PPGE- USP, Universidade de São Paulo, São Paulo, 2014.

[17] AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA – ANEEL. Resolução Nº 482, de 17 de abril de 2012. Biblioteca virtual. Disponível em www.aneel.gov.br. Acesso em: 18 de abril de 2022.

[18] BRAGA, R. P. Energia Solar Fotovoltaica: Fundamentos e Aplicações. Universidade Federal do Rio de Janeiro, Escola Politécnica, Departamento de Engenharia Elétrica,Novembro, 2008.

[19] Pequeno, M. R. D., de Matos Marques, R. S., & dos Santos, S. Analysis of the Use of Photovoltaic Solar Energy as a Source of Alternative Energy in Manaus City, 2019.