ASSESSMENT OF THE FEASIBILITY OF BASIC ENERGY INCOME AS AN ALTERNATIVE TO TSEE FOR LOW-INCOME FAMILIES THROUGH COMPUTATIONAL MODELING

Jonathas Pereira Campos - pereira.campos@academico.ifg.edu.br
Neville Julio de Vilasboas e Santos - neville.santos@ifg.edu.br
Daywes Pinheiro Neto - daywes.neto@ifg.edu.br
Raphael de Aquino Gomes - raphael.gomes@ifg.edu.br
Instituto Federal de Goiás – Goiânia – GO

Abstract. *Access to electricity is a fundamental right and a prerequisite for social inclusion and economic development. In Brazil, a significant portion of the population still faces energy poverty, despite the existence of social policies such as the Electricity Social Tariff (TSEE). However, the current subsidy model has proven increasingly costly and inefficient, raising concerns about its long-term sustainability. This study proposes a computational model to assess the technical and economic feasibility of replacing the TSEE with the Programa Renda Básica Energética (Rebe), based on decentralized solar photovoltaic generation. The model integrates real-world data, including consumption profiles, generation parameters, and financing structures, to simulate comparative scenarios. The results, applied to the state of Goiás, show that the total investment required for photovoltaic deployment would be offset in just over six years of current subsidies, suggesting that the Rebe could be a viable and equitable alternative for promoting energy justice and reducing structural inequalities in Brazil's electricity sector.*

Keywords: *Social tariff, Distributed photovoltaic generation, Energy justice, Public policy modeling*

1. INTRODUCTION

Access to electricity is a fundamental right and a central element for social inclusion, economic development, and improving quality of life. However, in Brazil, a significant portion of the population still lives in what is known as energy poverty, a condition in which families struggle to afford basic electricity services or have insufficient and unstable access to this resource (Silva et al., 2024). This situation is particularly dire among low-income groups, who, even when included in assistance programs, continue to face high tariffs and disruptions in supply.

In this context, public policies such as the Social Electricity Tariff Program (TSEE) become fundamental instruments for mitigating the effects of inequality in the energy sector. Created in

2001, the TSEE grants discounts on energy bills to families registered in the Single Registry for Social Programs (CadÚnico), acting as a social protection mechanism (Santos et al., 2023).

However, in recent decades, the Brazilian electricity sector has faced new challenges, such as rising generation and distribution costs driven by water crises, regulatory changes, and increased demand. These factors have intensified regional inequalities and compromised the effectiveness of the TSEE, making clear the limitations of the current model in ensuring energy justice for all (Hunt et al., 2018). Furthermore, recent studies indicate that subsidy policies such as TSEE can have regressive effects, disproportionately benefiting higher-income families and passing on costs to the most vulnerable consumers (Konzen et al., 2024). In light of this, there is growing debate about the need to replace traditional tariff subsidies with structural and more sustainable policies that promote lasting and autonomous access to energy.

Several proposals have been discussed in academic and political circles to transform this scenario. One of the most promising alternatives is to replace TSEE with initiatives involving distributed generation of photovoltaic solar energy for low-income households. Recent research shows that this replacement is economically viable, presenting significant returns on investment (Guedes et al., 2023; de Paula Sermarini et al., 2023). Other works discuss the legal incentives for the adoption of renewable technologies, as provided for in Law No. 14,300/2022, and the challenges of targeting public policies (Mitsuhashi and Blanchet, 2023; Goularte et al., 2024).

In this context, this article aims to present a computational model that enables the analysis of the feasibility and impacts of Bill No. 624 of 2023, which establishes the Basic Energy Income Program (BEIP) (Câmara dos Deputados, 2023). The proposed model integrates socioeconomic data, technical parameters, and cost-benefit indicators to simulate comparative scenarios between the current tariff subsidy model and the distributed generation policy based on solar energy. Based on this computational framework, it will be possible to evaluate the potential effects of the new proposal in terms of equity, sustainability, and economic efficiency, providing a technical basis for improving public policies in the Brazilian electricity sector.

2. MATERIALS AND METHODS

Energy poverty is a phenomenon that occurs when individuals or families are unable to access or afford essential energy services for a dignified life, such as lighting, cooling, heating, and the use of basic household appliances. In the Brazilian context, this problem is closely tied to social and regional inequalities, particularly in peripheral urban areas and rural regions. According to Hunt et al. (2018), the contemporary energy sector in the country has proven particularly challenging for vulnerable populations who face high electricity costs and instability in electricity supply.

The notion of energy justice proposes that access to energy should be distributed equitably, taking into account not only economic criteria but also social, environmental, and territorial ones (Bezerra et al., 2022). Promoting energy justice, therefore, requires public policies aimed at mitigating disparities in access to and cost of energy, ensuring that tariff structures or the energy transition does not disproportionately burden the poorest.

Aiming to be a solution to the problem of energy poverty, the Social Electric Energy Tariff (TSEE), established by Law No. 10,438/2002 and currently regulated by the National Electric Energy Agency (ANEEL) through Normative Resolution No. 1000/2021, consists of a tariff subsidy mechanism that grants progressive discounts on the energy bill of consumer units classified as low-income. The discount percentages vary according to the monthly consumption range: up to 30 kWh/month: 65% discount; from 31 to 100 kWh/month: 40% discount; from 101 to 220 kWh/month: 10% discount; above 220 kWh/month: normal rate.

Currently, Provisional Measure (MP) 1300/25 is being implemented, proposing free monthly consumption of up to 80 kWh. Those who consume more than 80 kWh per month would only pay the additional amount.

To be eligible for the benefit, the consumer unit must be linked to a family registered in the Single Registry (CadÚnico) with a monthly per capita income of up to half the minimum wage or with a member who receives the Continuous Benefit Payment (BPC). Adhesion, however, depends on an active registration stage, resulting in the underrepresentation of eligible families — that is, a deficit in program coverage.

The cost of the TSEE is offset by the Energy Development Account (CDE), a sectoral fund supplied by charges levied on all consumers, including those who do not directly benefit from the subsidy. This scenario generates a regressive redistributive effect, in which low-income consumers who are not registered with CadÚnico ultimately contribute to the program's financing. In contrast, large consumers may be partially benefited through indirect mechanisms (Konzen et al., 2024).

In addition, the continued growth of the subsidy compromises the sustainability of the CDE. Considering that, in 2025, with the current design, the amount allocated by the CDE to the TSEE is estimated to be R$6.7 billion, it is anticipated that, under the new rules of the MP, this CDE item alone will reach R$10.3 billion per year (Estadão Conteúdo, 2025). The current model, therefore, poses challenges in terms of targeting, equity, and economic efficiency.

As an alternative to the TSEE, Bill No. 624/2023 proposes the creation of the Basic Energy Income Program (Rebe), which aims to gradually replace the tariff subsidy model with a model based on energy self-sufficiency from renewable sources, especially solar photovoltaic. The program envisions the amendment of Laws No. 10,438/2002, 14,182/2021, and 14,300/2022, creating new financial, technical, and regulatory support mechanisms for low-income families.

Still in progress, Bill No. 624/2023 does not detail the operational mechanisms for implementation, such as eligibility criteria, counterparts, forms of financing for photovoltaic systems, integration with the CDE, or coverage targets. For this reason, it is essential to develop computational models that simulate various scenarios for the application of the proposal, including budgetary impact analysis, to support legislative decisions based on evidence.

Several countries have adopted alternatives to the traditional social energy tariff, promoting direct access to renewable energy generation as a means to combat energy poverty. In India and South Africa, programs have been implemented that combine subsidies for the installation of home solar systems with free electricity for a minimum consumption level, especially in remote areas. These models have proven effective, providing not only access to energy but also generating positive impacts on the quality of life of the populations served. In the United States, initiatives such as Solar for All offer access to solar generation, either individually or in the community, to low-income families, resulting in direct reductions in electricity bills (Brum Rosa et al., 2018). In Latin American countries such as Chile, Mexico, and Peru, several local projects implement solar kits with support from the public or social organizations, promoting social inclusion and the use of clean energy sources. These international experiences demonstrate not only the feasibility of replacing tariff subsidies with autonomous generation models but also reinforce the importance of integrated policies and incentives for renewable energy as effective strategies in combating energy poverty (Pereira et al., 2017).

This article proposes the development of a computational model to evaluate the technical, economic, and distributive viability of the Rebe in light of real data from the electricity sector and the current subsidy structure.

3. PROPOSED MODELING

The proposed modeling assumes that the installation of photovoltaic systems employs a centralized generation model, which involves the production of electricity in large plants, typically located far from consumption centers, and subsequently distributed through transmission networks. This assumption aims to simplify the analysis of the scenario. In this context, each photovoltaic plant generates a monthly amount of energy given by Equation 1:

$$G_{u_i} = P_u \cdot \left(\frac{I}{I_{ref}}\right) \cdot PR \cdot (1 - \delta_u)^{i-1} \cdot 365 \tag{1}$$

where G_{u_i} is the power generation by the plant in year i (in kWh); P_u is the nominal power of the plant (in kWp); I is the average daily solar irradiation received at the photovoltaic panel plane (in kWh/m^2/day); I_{ref} is the reference solar irradiation (1 kW/m^2); PR, or Performance Ratio, indicates the overall efficiency of the system. It represents the relationship between the electrical energy produced by the system and the energy theoretically expected under ideal conditions, taking into account losses related to the system's efficiency, environmental conditions, and other factors. It generally varies between 0.75 and 0.85, depending on the quality of the system and the installation conditions (Ábio Xavier Cardoso de Jesus et al., 2023); δ_u is the annual degradation factor of the photovoltaic system, which refers to the rate at which the efficiency of the system decreases over time due to various factors such as material wear, component degradation, and prolonged exposure to environmental conditions. This degradation is typically expressed as an annual percentage of the system's initial efficiency. It is crucial for estimating energy production over the lifetime of the photovoltaic system, as well as for making accurate return-on-investment projections (Ábio Xavier Cardoso de Jesus et al., 2023).

3.1 Energy bill

In this initial version of the computational modeling, the simulations focus on Group B consumers, who represent the target audience of the Basic Energy Income Program (Rebe). As provided for in Law No. 14,300/2022, consumers with medium-voltage distributed generation can opt for the tariff classification in Group B, provided they meet the criteria, such as limiting the installed power to up to 112.5 kVA and the local installation of the system (§1 of Article 11 of the aforementioned law).

The invoice calculation structure varies depending on whether a photovoltaic system is present or not. In scenarios without distributed generation, the invoice is calculated directly based on recorded consumption and current tariffs, including taxes and sector charges. In scenarios with distributed generation, the model considers energy credits and the tariff impacts of compensation, enabling comparative analyses between the current subsidy model and the Rebe proposal.

Since the simulated scenario involves the adoption of a photovoltaic system, the electricity bill calculation methodology incorporates the logic of the Electric Energy Compensation System (SCEE), as defined by Law No. 14,300 of January 6, 2022. In this configuration, the computational modeling considers the excess generation injected into the grid and the consequent formation of energy credits, which can be used to reduce the consumer unit's consumption in future periods. The local distributor manages these credits, and their use is limited to 60 months; after this period, any unused credits expire.

This behavior is replicated in the model structure, which accounts for valid credits and automatically disregards those that exceed the regulatory period. In this way, the simulator faithfully reflects the economic impacts of distributed generation in the context of the proposed policy, allowing its viability to be assessed in light of the current tariff subsidy model.

It is essential to note that, for photovoltaic systems connected before January 6, 2023, the concessionaire applies an additional charge known as Availability Cost (CD), which corresponds to the minimum value required to ensure the use of the electricity grid, as stipulated in current legislation. The CD value varies according to the type of connection: single-phase, two-phase, or three-phase, and is equivalent to the consumption of 30 kWh, 50 kWh, and 100 kWh, respectively.

In the computer model developed, this charge is incorporated into the scenarios in which it is applied, ensuring greater adherence to the regulatory reality. In addition, since bidirectional meters only record the flows of injected and consumed energy, the model's structure simulates the behavior of instantaneous (simultaneous) consumption of photovoltaic generation. Part of the energy generated is consumed simultaneously, according to a simultaneity factor defined by the user, while the surplus is directed to the grid. The additional consumption is supplied directly by the distributor.

To avoid distortions caused by oversizing or undersizing of simulated systems, the modeling limits the value of simultaneous consumption to the lowest value between total generation and total consumption, multiplied by the simultaneity factor, as shown in Equation 2. This approach ensures a more realistic estimate of the energy effectively used at the time of generation.

$$C_{s_k} = \min\left(\gamma \cdot \frac{G_t}{K}, \gamma \cdot C_k\right) \tag{2}$$

where C_{s_k} is the simultaneous consumption of a Consumer Unit (CU) k; γ is the simultaneity factor; G_t is the total energy generation; K is the total number of CUs; C_k is the consumption of CU k.

Therefore, the non-simultaneous consumption (C_{ns}) of CU k is given by Equation 3.

$$C_{ns_k} = C_k - C_{s_k} \tag{3}$$

Likewise, the generation injected into the grid (G_i) is given by Equation 4.

$$G_i = G_t - \sum_{k=1}^{K} C_{s_k} \tag{4}$$

Based on the defined parameters, the computational modeling performs the calculation of the energy flow according to the logic represented in the Figure, considering as main inputs: (i) the energy generated and injected into the grid (G_i), (ii) the non-simultaneous consumption (C_{ns}) and (iii) the availability cost (CD). The structure of the model allows the identification of different scenarios from the relationship between G_i and C_{ns}, reflecting the possible situations faced by consumers with distributed generation (adapted from Ábio Xavier Cardoso de Jesus et al. (2023)):

1. If $G_i > C_{ns}$: consumers generate more energy than they consume, and the accumulated credit corresponds to $G_i - (C_{ns} - CD)$, while the discount on the bill is $C_{ns} - CD$;

2. If $G_i = C_{ns}$: the credit generated is equivalent to the value of CD, with a discount on the bill of $C_{ns} - CD$;

3. If $G_i < C_{ns}$: there are two possibilities: (i) if $G_i - (C_{ns} - CD) < 0$, the credit used will be the lowest value between the available credit and $(C_{ns} - CD) - G_i$, and the discount will be the sum of G_i and this credit; (ii) if $G_i - (C_{ns} - CD) = 0$, there is no generation or use of additional credit, and the discount remains $C_{ns} - CD$.

This calculation logic was incorporated into the simulator to ensure consistency with the functioning of the Electric Energy Compensation System, allowing for the accurate simulation of the financial impacts of the distributed generation policy, both in the current model and in the one proposed by Bill No. 624/2023.

Finally, the computational modeling calculates the energy bill, in reais, based on Equation 5, which incorporates non-simultaneous consumption (C_{ns}), the value of the credit deduction (A), the energy tariff of the concessionaire (T_E), and the Distribution System Usage Tariff (TUSD) applied specifically to the deducted portion. In this context, the deduction corresponds to the amount of energy injected into the grid that was effectively converted into credit and is, therefore, subject to the incidence of TUSD Fio B, as provided for in the current regulations.

$$\text{Invoice} = (C_{ns} - A) \cdot T_E \cdot \text{TUSD} \tag{5}$$

It is worth noting that Law No. 14,300/2022 establishes specific guidelines for billing consumer units participating in the SCEE that are not covered by the exceptions in art. 26. The legislation defines increasing percentages of payment for the tariff components associated with the remuneration and depreciation of distribution assets, as well as the operation and maintenance costs of these services. These percentages start at 15% in 2023 and increase progressively, reaching 90% by 2028. However, in order to simplify the modeling and reduce the need for constant updates — especially about the collection of annual TUSD data from the user —, the proposed computational structure adopts a conservative approach: in all simulations, the full value of 100% of TUSD Fio B is considered applied throughout the analysis horizon.

3.2 Financing

To estimate the costs involved in implementing the bill, it is essential to analyze different financing modalities widely adopted by banking institutions. In this sense, two amortization systems will be evaluated: the Price System (also known as the French Amortization System) and the Constant Amortization System (SAC).

The Price System stands out for presenting fixed installments throughout the financing period, which facilitates financial control and planning. However, in the first years, a large part of the amount paid corresponds to interest, while the principal amortization is smaller, which can increase the total cost of financing. Over time, the proportion of the installment allocated to paying off the debt increases, gradually reducing the outstanding balance. In this amortization system, the Fixed Installment (PMT) is given by the Equation 6:

$$PMT = PV \cdot \frac{j(1+j)^n}{(1+j)^n - 1} \tag{6}$$

where PV is the financed amount (present value); j is the interest rate per period; n is the total number of installments.

Therefore, the annual expense for year i does not vary according to the year, and is calculated by the Equation 11:

$$\text{Annual expenditure PRICE}_i = PMT \cdot 12 \tag{7}$$

where Annual expense PRICE_i is the annual expense for year i considering the PRICE system; PMT is the fixed installment.

The SAC System is characterized by keeping the amortization value constant in all installments while the interest decreases progressively. This feature provides a faster reduction in the outstanding balance compared to the Price System. On the other hand, the initial installments are higher, gradually reducing as the interest charges decrease.

Since the installments in the SAC system are not fixed, to determine a value in a given period t, the amortization value must first be determined, which is given by Equation 8:

$$A = \frac{PV}{n} \tag{8}$$

Next, it is necessary to determine the interest in a given period, according to Equation **??**:

$$J_t = SD_{t-1} \cdot j \tag{9}$$

where J_t is the interest amount in a period $t \in \{1, \ldots, n\}$; SD_{t-1} is the outstanding balance in period $t-1$; j is the interest rate per period.

Therefore, the payment amount in period t is given by Equation 10:

$$PMT_t = A + J_t \tag{10}$$

Using the SAC system, to determine the amount spent in a year, it is necessary to add month by month since the installments vary each month. This is done through the Equation 11

$$\text{Annual expenditure SAC}_i = \sum_{t=12(i-1)+1}^{12i} PMT_t \tag{11}$$

where Annual SAC expenditure_i is the annual expenditure for year i considering the SAC system; PMT_t is the portion in period t.

4. APPLICATION OF THE MODEL

The application of the model proposed in this initial phase was deliberately simplified to enable a preliminary analysis of the technical and economic feasibility of the Rebe Program. It was decided not to incorporate, at this stage, more complex variables such as financing mechanisms, amortization, regionalized compensation schemes, or tariff variations over time. These methodological choices do not indicate a disregard for reality, but rather the adoption of an incremental approach, common in exploratory studies, which aims to ensure clarity in the results and facilitate understanding of the program's fundamental impacts. The inclusion of more detailed financial aspects will be the subject of later phases of the study, using the same computational framework, which already includes a structure for simulating financing via Price and SAC systems, as described in Section 3..

To analyze the technical and economic feasibility of the Rebe Program, the model was applied to a projection of future consumption, considering a 25-year horizon that corresponds to the estimated useful life of a photovoltaic system. The estimated monthly energy generation to be subsidized (approximately 0.66 TWh) was obtained from the historical consumption data of TSEE beneficiaries in the state of Goiás, using the Holt-Winters Exponential Smoothing method Winters (1960). This statistical technique is widely used in trended and seasonally adjusted time series, as it allows for more robust projections than simpler methods, such as moving averages, especially in long-term contexts and when dealing with cyclical variations.

The projected monthly average was converted to a daily value (0.02 TWh/day), and this value was used to estimate the required photovoltaic power using Equation 1 of the theoretical model. The following technical parameters were adopted: an average irradiance of 5.26 kWh/m²/day, a reference irradiance of 1 kW/m², and an initial PR of 0.8, with a degradation rate of 0.01 per year. Considering this decrease over time, a weighted average PR of 0.68 was adopted.

With these parameters, the estimated power to meet demand was 6.19 GWp. For cost estimation, a unit value of R$4,000.00 per installed kWp was used as a reference, based on the model's reference plant and previous studies (Neto et al., 2024). With these assumptions, the total investment for constructing the centralized plant would be R$24.76 billion.

Figure 1 shows the evolution of the monthly energy required to serve consumers currently benefiting from the TSEE. The projection indicates a continued increase, reaching 1.1 TWh per month by 2050. This growth reflects the increased demand and highlights the future pressure on subsidy mechanisms.

Figure 2 shows the projected monthly cost of the TSEE, which could exceed R$0.6 billion/month in the coming decades. Over the next 25 years, the cumulative cost of the TSEE, according to the model, is estimated at R$28.56 billion. In contrast, the cumulative cost of energy that would need to be subsidized via the conventional grid (without changes to the current model) would reach R$116.61 billion.

Comparing these figures with the cost of implementing the photovoltaic plant (R$24.76 billion), the economic viability of the Rebe proposal becomes clear. Replacing the traditional tariff subsidy with a self-generation system represents significant savings, both in the direct cost of the TSEE and the projected total cost of subsidized energy via the grid. In addition to the economic advantage, Rebe has the potential to guarantee greater energy autonomy for low-income families and contribute to the sustainability of the electricity sector.

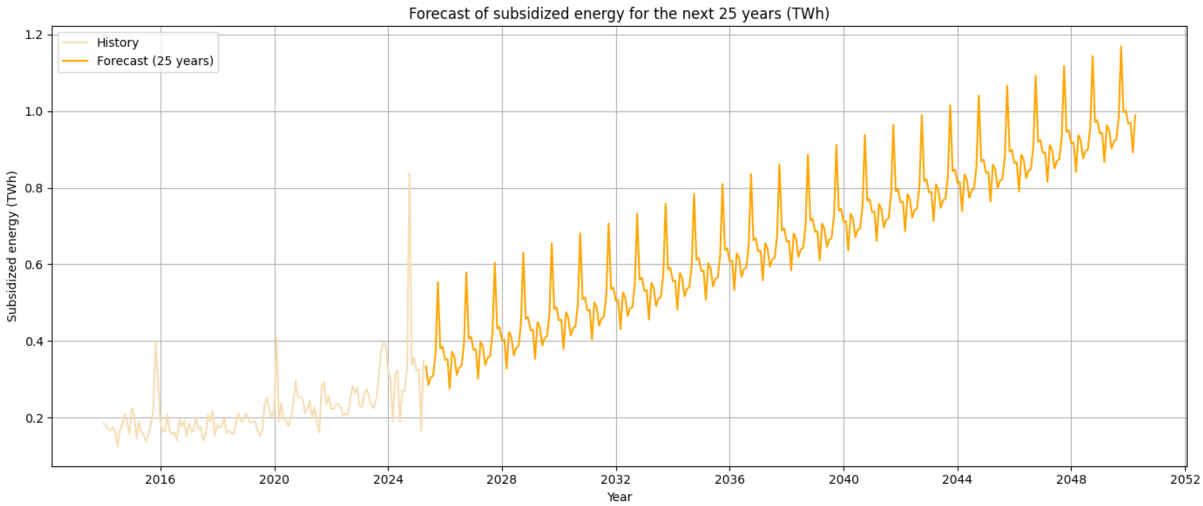

Figure 1: Forecast of energy subsidized by the Rebe program (TWh).

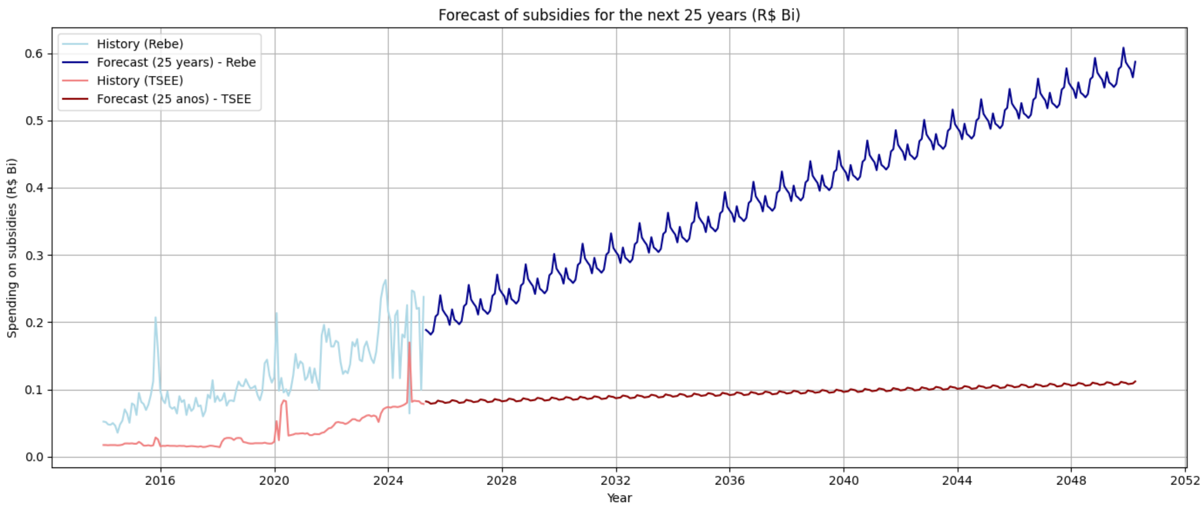

Figure 2: Forecast of accumulated subsidies (R$ billions).

5. CONCLUSIONS

This paper presents a computational model developed to assess the technical, economic, and distributive feasibility of the Basic Energy Income Program (Rebe), proposed by Bill No. 624/2023, as an alternative to the current model of the Social Electricity Tariff (TSEE). Based on the integration of technical parameters, socioeconomic data, and financial simulations, it was possible to estimate the program's impacts in terms of distributed photovoltaic solar energy generation for low-income consumers.

The results indicate that the progressive replacement of tariff subsidies by renewable self-generation is not only technically feasible but also presents significant economic advantages in the medium term. The analysis applied to the state of Goiás demonstrated that the cost of installing photovoltaic systems could be offset in approximately six years through the TSEE subsidy while promoting greater energy autonomy and reducing the regressiveness of the current financing model via CDE.

The proposed framework enables the simulation of multiple regulatory and financial scenarios, allowing adjustments based on different amortization mechanisms, radiation conditions, and consumption profiles. Thus, the model is a promising tool to support legislative decisions and contribute to the improvement of fairer, more sustainable, and efficient public policies in the Brazilian electricity sector.

REFERENCES

Bezerra, P., Cruz, T., Mazzone, A., Lucena, A. F. P., Cian, E. D., and Schaeffer, R. (2022). The multidimensionality of energy poverty in brazil: A historical analysis. *Energy Policy*.

Brum Rosa, C., Mairesse Siluk, J. C., Michels, L., Donaduzzi Rigo, P., and Rediske, G. (2018). A gestão da energia solar fotovoltaica sob a ótica da bibliometria. *Tecno-Lógica*, 22(2).

Câmara dos Deputados (2023). Projeto de lei n° 624, de 2023: Institui o programa renda básica energética (rebe); e altera as leis nºs 10.438, de 26 de abril de 2002, 14.182, de 12 de julho de 2021, e 14.300, de 6 de janeiro de 2022. `https://www25.senado.leg.br/web/atividade/materias/-/materia/163678`. Acesso em: 27 maio 2025.

de Paula Sermarini, A. C., Paulino Azevedo, J. H., de Albuquerque, V. C., Calili, R. F., Gonçalves, F., and Jannuzzi, G. (2023). The proposition of a public policy to stimulate low-income communities' assess to distributed energy resources. In *2023 IEEE 50th Photovoltaic Specialists Conference (PVSC)*, pages 1–3.

Estadão Conteúdo (2025). Abrace: consumidor industrial pode ter alta de até 200% na CDE com reforma do setor elétrico. Acesso em: 27 maio 2025.

Goularte, K. M. C., Muniz, P. R., and Nunes, R. B. (2024). Tarifa social de energia elétrica: análise crítica e propostas de adequação. *REVISTA DELOS*, 17(60):e2041.

Guedes, P. E. A., De Rezende, J. A. M., Da Costa, V. B. F., Aquila, G., and Bonatto, B. D. (2023). Supplying electricity demand to low-income residential consumers through photovoltaic generation: A sustainable alternative to electrical energy social tariff. In *2023 15th IEEE International Conference on Industry Applications (INDUSCON)*, pages 366–371.

Hunt, J. D., Stilpen, D., and de Freitas, M. A. V. (2018). A review of the causes, impacts and solutions for electricity supply crises in brazil. *Renewable and Sustainable Energy Reviews*, 88:208–222.

Konzen, G., Best, R., and de Castro, N. D. (2024). The energy injustice of household solar energy: A systematic review of distributional disparities in residential rooftop solar adoption. *Energy Research & Social Science*.

Mitsuhashi, N. S. and Blanchet, L. A. (2023). O fomento público e a energia solar fotovoltaica a partir da lei nº 14.300/2022. *Prisma Juridico*, 22(2):389–402.

Neto, D. P., Coimbra, A. P., De Almeida, A. T., Almeida, T. R., Moura, P., Ucker, L. C., Gomes, R. A., and Magalhães, A. S. (2024). A comprehensive methodology for assessing the economic viability of ev charging infrastructure in brazil. In *2024 6th International Conference on Smart Power & Internet Energy Systems (SPIES)*, pages 232–238. IEEE.

Pereira, E. B., Martins, F. R., Gonçalves, A. R., Costa, R. S., Lima, F. d. P. A., Ruther, R., Abreu, S. L. d., Tiepolo, G. M., Pereira, S. R., and Souza, J. R. (2017). Atlas brasileiro de energia solar.

Santos, N. S. d., Félix, D. d. S., Cançado, A. C., Sousa, I. N. F. d., and Rodrigues, W. (2023). Política social de energia elétrica no estado do tocantins. *Desenvolvimento Em Questão*, 21:e13173.

Silva, T. D. D., Pavanelli, J. M. M., and Bellini, G. C. (2024). A pobreza energética no estado do maranhão e o programa fne sol nordeste. In *Anais do XI Encontro Nacional da ANPPAS*, Curitiba, PR. UFPR. Acesso em: 27 maio 2025.

Winters, P. R. (1960). Forecasting sales by exponentially weighted moving averages. *Management science*, 6(3):324–342.

Ábio Xavier Cardoso de Jesus, Neto, D. P., and Domingues, E. G. (2023). Computational tool for technical-economic analysis of photovoltaic microgeneration in brazil. *Energy*, 271:126962.