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Alternativas de financiamento a projetos de geração distribuída de energia renovável

Financing alternatives for distributed renewable energy generation projects

Alternativas de financiamiento para proyectos de generación distribuida de energía renovable

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Resumo: Apesar da existência de um arcabouço regulatório para a micro e minigeração distribuída no Brasil, a expansão desse modelo de produção e consumo de energia renovável ainda enfrenta obstáculos financeiros e institucionais. Este artigo tem como objetivo identificar instrumentos jurídicos e financeiros capazes de fomentar a implementação de projetos de geração distribuída por micro e pequenas empresas. A metodologia adotada é qualitativa, de caráter exploratório e aplicada, baseada em revisão bibliográfica e documental de fontes institucionais nacionais e internacionais. Como principais resultados, o estudo apresenta propostas de engenharia financeira envolvendo fideicomisso, fundos garantidores e contratos de compra de energia, articulados a modelos híbridos de financiamento com o apoio de instituições financeiras de desenvolvimento. Conclui-se que a adoção desses instrumentos pode ampliar o acesso ao crédito, reduzir riscos e estimular a participação do setor privado em iniciativas alinhadas à transição energética e ao desenvolvimento sustentável.

Palavras-chave: desenvolvimento sustentável; instrumentos financeiros; micro e pequena empresa; bancos de desenvolvimento.

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Abstract: Although a regulatory framework for micro and mini distributed generation exists in Brazil, the expansion of this model of renewable energy production and consumption still faces financial and institutional barriers. This article aims to identify legal and financial instruments capable of fostering the implementation of distributed generation projects by micro and small enterprises. The methodology is qualitative, exploratory, and applied in nature, based on a bibliographic and documentary review of national and international institutional sources. The main results include proposals for financial engineering involving trusts, guarantee funds, and power purchase agreements, combined with hybrid financing models supported by development financial institutions. It is concluded that the adoption of these instruments can expand access to credit, reduce risks, and encourage private sector participation in initiatives aligned with the energy transition and sustainable development.

Keywords: sustainable development; financial instruments; small and micro enterprises; development banks.

Resumen: A pesar de la existencia de un marco regulatorio para la micro y mini generación distribuida en Brasil, la expansión de este modelo de producción y consumo de energía renovable aún enfrenta obstáculos financieros e institucionales. El objetivo de este artículo es identificar instrumentos jurídicos y financieros capaces de fomentar la implementación de proyectos de generación distribuida por parte de micro y pequeñas empresas. La metodología adoptada es cualitativa, de carácter exploratorio y aplicada, basada en una revisión bibliográfica y documental de fuentes institucionales nacionales e internacionales. Como principales resultados, el estudio presenta propuestas de ingeniería financiera que incluyen fideicomisos, fondos de garantía y contratos de compraventa de energía, articulados con modelos híbridos de financiación con el apoyo de instituciones financieras de desarrollo. Se concluye que la adopción de estos instrumentos puede ampliar el acceso al crédito, reducir los riesgos y estimular la participación del sector privado en iniciativas alineadas con la transición energética y el desarrollo sostenible.

Palabras clave: desarrollo sostenible; instrumentos financieros; micro y pequeñas empresas; bancos de desarrollo.

1. Introduction

The pursuit of energy stability, as well as ensuring national security, has been gaining prominence in public policy, especially after the oil crises of the 1970s. Since then, many countries have fostered research programs aimed at exploring renewable energy alternatives.

In Brazil, some federal government initiatives.[2] These efforts represent efforts to promote renewable sources and promote the efficient use of energy. Brazilian authorities'

[2] National Alcohol Program (Proálcool); National Electric Energy Conservation Program (Procel); National Program for the Rationalization of the Use of Petroleum and Natural Gas Derivatives (CONPET);

commitment to diversifying the country's energy matrix was ratified with the country's accession to the Paris Agreement in 2016.

Globally, renewable sources—solar, wind, geothermal, hydroelectric, and biomass—account for 14.7% of the global energy matrix (BEN, 2024). Meanwhile, renewable sources in the Brazilian energy matrix—derived from sugarcane, hydroelectric power, firewood, charcoal, and other renewable sources—account for 49.1% (BEN, 2024). Thus, the Brazilian energy matrix can be considered renewable, especially when compared to the global energy matrix. If we consider only the sources available for electricity generation, it can be said that the Brazilian energy matrix is even more renewable. The share of renewable sources in the Brazilian energy matrix reached 89.2%, while the global aggregate reached 28.7% (BEN, 2024). However, the Brazilian electricity matrix is heavily concentrated in large centralized generation projects (or utility-scale), given that hydroelectric plants account for 58.9% of the domestic electricity supply. Meanwhile, the decentralized modality, embodied in micro and mini distributed generation projects from alternative renewable sources, is still underutilized, especially considering Brazil's generation expansion capacity. Despite ANEEL Normative Resolution No. 482/2012, which established the regulatory framework for micro and mini distributed generation, it appears that the greater expansion of this category lacks better coordination of policy instruments. A study by the Brazilian Business Council for Sustainable Development – CEBDS (2016) identified the main barriers to the diffusion of distributed generation: information, investment, and a lack of appropriate financial products and business models. Given this scenario, this article aims to propose financing alternatives for distributed renewable energy generation projects aimed at micro and small businesses, based on an analysis of existing and potential legal and financial instruments. The proposal is based on the assumption that the combination of market mechanisms and public development policies can enable innovative financing models and reduce the risks associated with this type of enterprise.

To this end, a qualitative, exploratory, and applied approach was adopted. The research is based on a bibliographic and documentary review of national and international institutional sources. The analysis focused on identifying barriers and formulating structured solutions, such as trusts, guarantee funds, and power purchase agreements. The alternative business

Brazilian Labeling Program (PBE); Energy Efficiency Law; Emergency Wind Energy Program (PROEÓLICA); Program to Incentive Alternative Sources of Electric Energy (PROINFA); National Program for the Production and Use of Biodiesel (PNPB).

model presented, applicable to small hydroelectric, biomass, wind, and photovoltaic projects, also offers new financial investment opportunities for institutional investors.

2. Theoretical Framework

According to the International Energy Agency (IEA, 2011), government authorities and the consumer market promote efforts to disseminate renewable energy technologies for three interconnected reasons: ensuring energy security, fostering economic development, and protecting the climate and environment from the impacts of fossil fuel use.

In this way, governments seek to guarantee a sufficient and reliable energy supply to meet demand at all times and at affordable prices (IEA, 2011). Generally speaking, conventional and renewable energy sources differ in several aspects, such as storage possibilities, extraction requirements, and reserve capacity.

Unlike renewable sources, conventional energy resources can be stored indefinitely, so a disruption in their supply at a given juncture can generate economic benefits for an exporting country—which, however, poses availability problems for importing countries. Furthermore, fossil fuels, whose reserves are gradually depleting, require significant labor for their extraction, which is generally done in large-scale facilities. Renewable sources, on the other hand, are freely available and are exploited through natural processes.

In short, renewable energies are less exposed to certain supply risks and can increase overall energy availability (IEA, 2011). Furthermore, renewable energy sources provide an alternative to the increasingly uncertain and volatile fossil fuel market. The large fluctuations in the prices of conventional energy sources have deleterious economic impacts. In a targeted study, Awerbuch and Sauter (2006) estimate a 0.5% loss in GDP for a 10% increase in oil prices for the United States and the European Union.

The spread of renewable energy-related technologies is also crucial for climate and environmental protection policies. Climate change, caused primarily by the rampant emission of greenhouse gases (GHGs), is strongly associated with the burning of fossil fuels. Ongoing global warming has the potential to bring disastrous consequences, such as the risk of species extinction, increased waves of mass migration to escape environmental disasters such as floods and prolonged droughts, and the possibility of serious regional conflicts, in addition to the resulting economic losses.

Therefore, the proliferation of technologies related to renewable energy generation, in addition to mitigating the effects of climate change, promotes well-being and contributes to sustainable economic development.

The energy transition toward renewable sources can be implemented through centralized generation (utility-scale) and distributed generation projects. Centralized generation projects are characterized by large-scale power generation units, which require significant investments. Historically, the Brazilian electricity sector has been structured based on centralized generation, with predominance of large hydroelectric plants and, to a lesser extent, thermoelectric plants. Distributed generation projects are small-scale generators whose electricity is produced at or near the point of consumption, thus characterized by its diffuse nature. This type of energy generation includes wind and photovoltaic power plants.

According to the Normative Resolution ANEEL nº 482/2012[3], Brazilian consumers are allowed to generate their own electricity from renewable sources and feed the remaining amount into the local distribution grid. This new method of producing and consuming electricity is known as distributed micro- and mini-generation.

In practice, distributed microgeneration refers to generating plants with installed capacity up to 75 kilowatts (kW), and distributed minigeneration refers to those with capacity above 75 kW and less than or equal to 5 MW, connected to the distribution grid through consumer unit installations (ANEEL, 2025). The possibility of establishing distributed energy projects in condominiums, consortia, or cooperatives was also established, in which multiple consumer units share the proceeds from the installation of a micro- or mini-generator.

ANEEL's regulatory framework also determined the rules and validity periods for energy credits. Therefore, in the month in which the energy generated exceeds the amount consumed, an energy credit is generated for the consumer unit, which can be used to reduce consumption in subsequent months, within the 60-month credit validity period. In this model, the local distribution grid acts as a kind of battery, storing the excess energy generated until the consumer unit demands energy from the distributor.

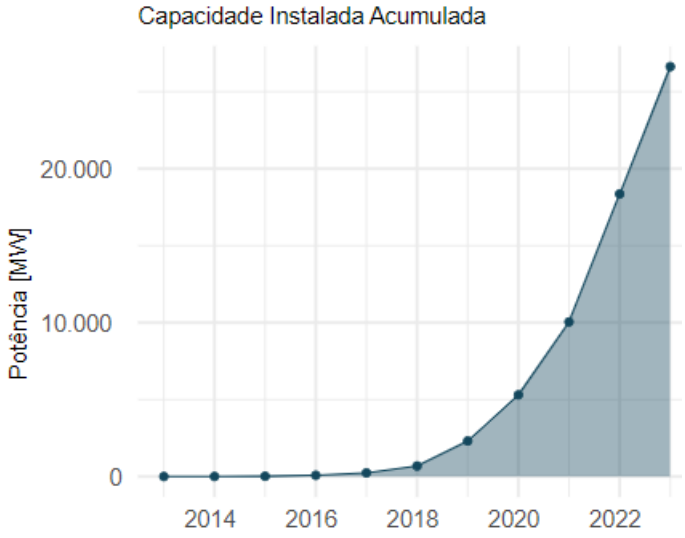
The spread of distributed generation projects can provide several benefits to the electrical system, such as postponing investments in expanding transmission and distribution systems, reducing environmental impact, reducing grid loads, minimizing losses, and diversifying the energy matrix (ANEEL, 2025). However, the initiative to implement micro- or mini-distributed generation projects is solely up to the consumer.

[3] This was later improved and replaced by the Normative Resolution ANEEL nº 1.059/2023.

Therefore, it is up to the consumer to analyze the cost-benefit ratio for installing generators. This analysis should take into account a series of factors, such as the type of energy source (solar panels, wind turbines, biomass generators, etc.), equipment technology, the size of the consumer unit and generating plant, the location (rural or urban), the tariff rate to which the consumer unit is subject, the existence of other consumer units that can benefit from electricity credits, and the payment/financing conditions of the project (ANEEL, 2025).

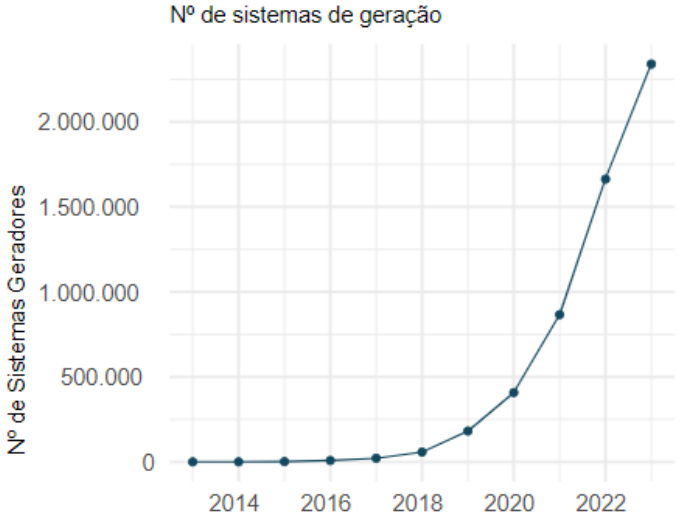
Considering the commercial and industrial sectors, an exponential growth pattern of micro and mini distributed generation has been observed in Brazil since the consolidation of the regulatory framework, whether based on accumulated installed capacity (graph 1), the number of generation systems (graph 2), or the number of consumers (graph 3).

Graph 1 – Cumulative installed capacity of distributed micro and mini generation



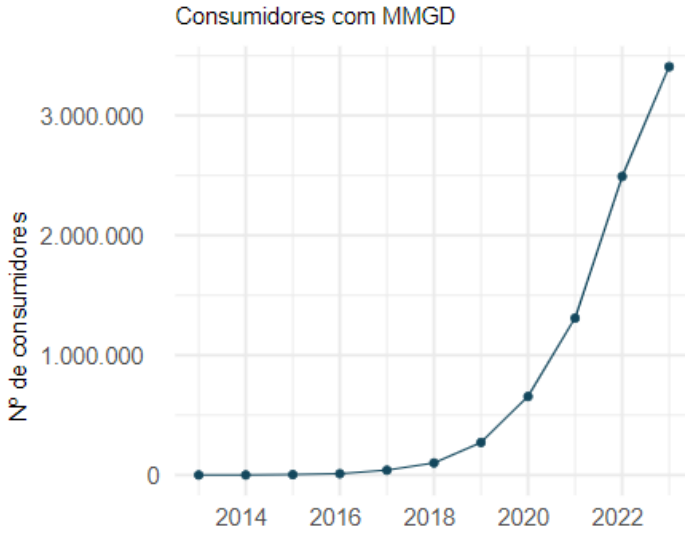
Source: Energy Research Corporation (2024)

Graph 2 – Number of micro and mini generators



Source: Energy Research Corporation (2024).

Graph 3 – Number of consumers of micro and mini distributed generation



Source: Energy Research Corporation (2024).

However, if we consider the expansion capacity of renewable electricity generation and the number of micro and small companies active in Brazil[4], We can infer that the implementation of micro and mini distributed generation projects from alternative renewable sources is still below potential due to several obstacles.

A study commissioned by CEBDS (2016) found that the main barriers to the spread of distributed generation in Brazil are related to information, investment, and a lack of appropriate financial products and business models.

Regarding information, the obstacle lies in the complexity of the product, which requires long-term projections of costs and benefits to justify project execution. Furthermore, the dissemination of micro and mini distributed generation occurs through referrals, which is often quite slow. Regarding investment, the main barrier to entry is the high initial cost, which in practice proves to be out of sync with the long-term benefits.

Regarding the lack of appropriate financial products and business models, the following stand out: the existence of few specific financing lines, difficulties in defining the physical guarantee of financing, and limited knowledge about alternative instruments.

3. Methodology

[4] Incorporating individual microentrepreneurs (MEI), we see that 99% of Brazilian businesses are micro and small. These total 20 million businesses, 14 million of which are MEIs (EBC, 2022).

This article adopts a qualitative and exploratory approach, predominantly applied in nature, aiming to identify, describe, and propose legal and financial instruments aimed at enabling distributed renewable energy generation in Brazil, especially for micro and small businesses.

The research is based on a bibliographic and documentary review, consulting primary and secondary sources, such as national legislation, resolutions of the National Electric Energy Agency (ANEEL), institutional publications from agencies such as BNDES, EPE, ABDE, and CEBDS, as well as specialized national and international literature on development financing, trusts, distributed generation, and energy sustainability.

The methodological strategy is based on mapping the main barriers to the adoption of micro and mini-distributed generation by small entrepreneurs, identified in empirical and institutional studies, and on the formulation of technical and regulatory alternatives that contribute to overcoming these barriers. The proposals were evaluated based on criteria such as operational feasibility, regulatory coherence, capital mobilization potential, and the ability to integrate public policy instruments with market mechanisms.

Based on this foundation, the study proposes combining legal instruments such as financial trusts and guarantee funds with established contractual mechanisms in the electricity sector, such as leasing contracts and power purchase agreements (PPAs), to structure financing models that convert capital expenditures into operating expenses, reduce risks, and expand access to credit.

Furthermore, the adopted methodology includes a theoretical exercise in institutional design, based on international benchmarks, especially from countries that have already incorporated trusts or similar structures as development financing tools. This approach allows for the identification of regulatory gaps in the Brazilian legal system and suggests ways to overcome them through legislative and administrative measures. In summary, the research articulates normative analysis, evaluation of financial instruments and formulation of institutional engineering proposals with a view to creating a more favorable environment for the insertion of distributed generation as a vector of sustainable development in Brazil.

4. Results and Discussions

The proposed financial engineering begins with the trust institution, which refers to a business structure through which an individual or legal entity (referred to as the trustor)

temporarily transfers ownership of certain assets or rights to another individual or legal entity (referred to as the fiduciary) until a stipulated purpose is fulfilled or a previously agreed-upon term has elapsed in favor of a third party (the trustee).

In the Brazilian legal system, the trust is linked to the inheritance function. In this sense, the Brazilian Civil Code, art. 1,951, states that:

"The testator may appoint heirs or legatees, stipulating that, upon his death, the inheritance or legacy shall be transferred to the trustee, with the latter's right being terminated upon his death, at a certain time or under certain conditions, in favor of another person, who is referred to as the trustee." (BRAZIL, 2002)

Some Latin American countries have expanded the trust institution beyond inheritance law.[5] Thus, the trust was incorporated into the trust, meaning that today the trust constitutes an important financing structure, providing an expansion of credit and mobilizing capital that, due to its intrinsic characteristics, would not otherwise circulate (Senra et al., 2007).

A key point in the legislation of these countries refers to the isolation of the trust assets, as they are separated from the assets of the trustor and the trustee. Because it constitutes an autonomous asset, the trust provides legal certainty by isolating both the previous assets from the newly contributed assets and the cash flows of the projects, eliminating the need to form a special purpose entity (SPE).

Depending on the origin of the assets that will comprise it, the trust can be public or private. Furthermore, depending on the purpose for which they are established, trusts can be categorized into various categories, such as administrative trusts, financial trusts, investment trusts, guarantee trusts, and mixed trusts. Given the scope of this work, not all categories will be discussed in detail, but only financial trusts, given their relevance to the subject matter of the study.

Financial trusts, therefore, correspond to the category that allows for the raising of funds through the issuance of debt securities, which generally have a risk rating and grant investors the right to participate in the proceeds of the trust's assets (Senra et al., 2007). Therefore, this type of framework often results in lower fundraising costs and, consequently, a higher rate of return on investments made through this structure (Catuogno, 2006). Furthermore, in some countries, tax exemptions are granted on trust securities issuances.

In this context, the financial trust becomes a central tool in designing mechanisms for the involvement of development banks established in economic policy. The versatility of the

[5] Argentina, Bolivia, Colombia, Costa Rica, Cuba, El Salvador, Ecuador, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela.

trust, therefore, allows development finance institutions to be used for a wide range of purposes, such as coordinating the various institutional actors involved, contributions to guarantee funds, acting as a fiduciary, or investing in the securities representing the scheme, for example.

Through the financial trust, therefore, development banks can create very favorable conditions to promote projects and productive activities where the mechanics of conventional credit markets appear insufficient to address the specific needs of certain financing needs.

Some countries have turned to trusts and other similar legal and financial structures as a way to facilitate investments in distributed renewable energy generation, especially when small players are involved and risk mitigation is needed. International experience offers useful references for Brazilian institutional design, highlighting models that combine financial innovation with a consolidated legal framework. In Mexico, the Trust for Electric Energy Savings (FIDE) is a notable example. It is a trust structure created to promote energy efficiency and distributed generation, primarily among microenterprises and residential consumers (FIDE, 2023). FIDE operates with public and private resources, offering guarantees, technical assistance, and long-term financing. The legal certainty provided by the trust is seen as a key element in attracting banks and encouraging project scaling.

In India, recent initiatives aimed at expanding decentralized solar energy have used hybrid financing instruments, such as trust funds backed by multilateral banks and power purchase agreements (PPAs). The Solar Energy Corporation of India (SECI), for example, acts as a project structuring agent, establishing long-term agreements with independent producers and redistributing risks through trust consortia overseen by state institutions (SECI, 2023). In Germany, we are seeing the consolidation of cooperative structures and local consortia that operate with a logic similar to that of trust funds. The so-called *Energiegenossenschaften* (energy cooperatives) bring together citizens, small business owners, and local authorities in arrangements that allow for the financing, construction, and operation of photovoltaic systems (Yildiz et al., 2015). These models receive institutional support from the federal government, including through partial guarantees and subsidies conditioned on shared governance.

These experiences reveal that trusts, or mechanisms with similar functions, can play a relevant role in mobilizing capital for distributed generation projects, especially when combined with risk mitigation strategies and public incentive policies. Adopting these models in the Brazilian context can help strengthen the energy transition financing system and expand small entrepreneurs' access to opportunities in this emerging market. Since Brazil does not

provide for the use of financial trusts to promote the infrastructure sector, and given the clear need for alternative financial instruments to support projects with positive externalities (environmental, economic, and social), it is proposed that financial trusts be regulated in the national legal system. The institutional challenge of fostering the development of sectors such as renewable energy generation involves reconciling policies that aim to achieve diverse objectives, from formalizing an appropriate regulatory framework for these activities to consolidating conditions that ensure an adequate competitive environment.

The National Development System (SNF) is comprised of public and private financial institutions whose mandate is to promote economic development through financing for strategic sectors. This set of institutions can be considered heterogeneous in several aspects, such as scope of action, competencies, and geographic reach. In the Brazilian case, the SNF is currently made up of more than 30 institutions, including multiple banks with development portfolios, cooperative banks, development agencies, state development banks, BNDES, Finep and Sebrae (see figure 1).

Figure 1 – Brazilian National Development System

Source: Brazilian Development Association (2025).

Due to the normative and regulatory complexity of this distinct group of entities and the specific objective of the proposal to be explained, this paper will not analyze the differences between its components and will consider regional development finance institutions (DFIs), especially development banks, for analytical purposes.

Specialized literature points to a series of factors that justify and advocate for the existence of DFIs. In a non-exhaustive list, the following can be highlighted: the need to mitigate market failures, optimize the supply of long-term credit, finance projects that, despite low profitability, incorporate positive externalities, and promote countercyclical actions (Cunha; Carvalho; Prates, 2014; Ferraz; Além; Madeira, 2013). Regarding the main activities carried out by regional DFIs, the highlights are long-term credit for investment projects, working capital, targeted productive microcredit operations, financing for innovation projects and lines of credit with the public sector to finance urban infrastructure projects (Horn; Feil, 2019).

Depending on the funding sources of regional DFIs, the most prominent are transfers from the BNDES (National Development Bank), Caixa Econômica Federal (Federal Savings Bank), Banco do Brasil (Brazilian Bank of Economic and Social Development), Finep (Finep), and international development finance institutions (International Development Banks), their own resources, and public funds and official programs (Horn; Feil, 2019).

Thus, it can be seen that the SNF in Brazil is largely operated through banking services and has little connection with the capital markets. This finding opens a significant window of opportunity for this type of integration, as the issuance of longer-term bonds that capture the interest of private investors can constitute an important source of funding for development banks.

Therefore, the offering of this type of instrument by development banks could be a significant catalyst for the deepening of financial markets and economic growth. The international benchmark suggests, based on the successful experiences of European DFIs, a high degree of diversity in their financing sources, which has allowed them greater administrative and decision-making autonomy, better risk management, and greater stability in financing flows (Titelman, 2003).

Furthermore, the international benchmark reveals that the participation of development banks in debt securitization and trust operations has been very beneficial in attracting resources for financing small businesses (Titelman, 2003). For development banks, trust operations can also be seen as a tool for risk mitigation and budgetary transparency, as their

implementation allows them to channel resources to activities with higher relative risk without affecting their financial position.

Another type of financial instrument that has been used to facilitate access to credit for small entrepreneurs is the loan guarantee fund. As this type of fund enables risk diversification and reduces transaction costs, it provides better access to credit and flexibility in collateral requirements. Therefore, guarantee funds can complement other instruments in supporting financial intermediation with micro and small businesses.

Once the main barriers to the dissemination of distributed micro and mini-generation projects have been identified, the proposal of policies and instruments aimed at overcoming them has a better foundation and greater potential for effectiveness. Given the high initial investment required, the lack of appropriate financial instruments, and the inherent difficulties in defining the physical collateral for existing credit lines, the introduction of new business models focused on distributed generation projects is particularly important.

Thus, several characteristics combine to make what is known as third-party financing viable. In this type of financial instrument, small businesses are exempt from the obligation of initial investment, converting initial capital expenditure (CAPEX) into operating expenditure (OPEX). Third-party financing takes two different forms: leasing and power purchase agreements (PPA).

In a leasing agreement, the small business undertakes to make monthly payments for the generator lease. In many cases, the agreement includes a buy-out clause for the asset at the end of the stipulated term.

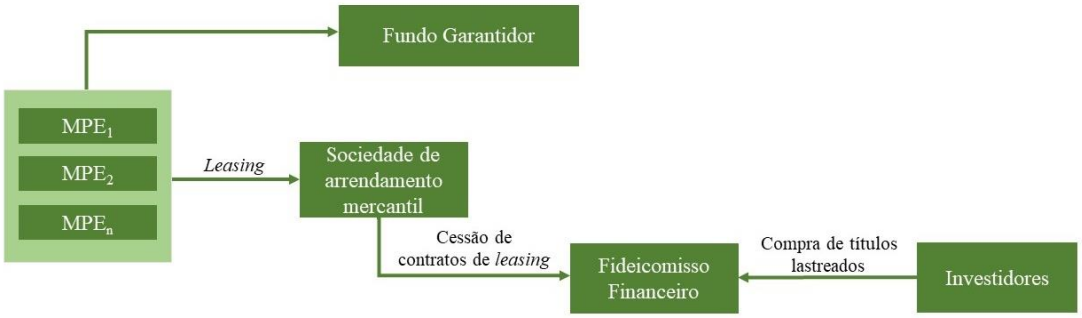
In the leasing structure proposed here, micro and small businesses organize themselves through consortia or cooperatives with the financial institution that operates this type of agreement (leasing company). The commercial leasing company (SAM), in turn, provides micro and small generators to entrepreneurs on a lease basis, meaning that the contracting parties are guaranteed use of the generators, but without ownership.

Concurrently, it is important to establish guarantee funds to cover risks that the financial system and capital markets do not assume. These guarantee funds, generally created by the government, will guarantee leasing transactions between micro and small businesses and SAM through the payment of a fee proportional to the contract.

SAM will then assign the credit rights under these leasing contracts to a trust institution—which could be a development bank, for example—which will establish the financial trust. This structure will securitize the receivables from the leasing contracts, creating backed debt securities that will be made available on the securities market. Thus, in

addition to representing a good alternative for making micro and mini distributed generation projects viable for small businesses, this financial engineering also provides a safe, profitable and environmentally sustainable investment alternative for individuals and legal entities (see figure 2).

Figure 2 – Financial engineering through leasing and financial trust



Source: Prepared by the author (2022).

On the other hand, a power purchase agreement (PPA) is a contractual instrument signed to facilitate the purchase and sale of electricity, especially from renewable sources. At the time of the transaction, all underlying details are agreed upon between the parties, such as the price to be paid for the electricity, the term, and the quantity of electricity generated for the buyer.

In the PPA agreement recommended here, the energy company is responsible for acquiring and operating the generator, and small entrepreneurs purchase the energy produced at a competitive price. The energy company, in turn, will transfer the credit rights under the PPA agreements to a trust institution—which could be a development bank, for example—which will establish the financial trust. This securitization process involves the securitization of the receivables under the PPA agreements, giving rise to backed debt securities that will be made available in the capital markets. This type of financial structure, illustrated in Figure 3, offers a series of advantages for both the micro and small business buyers and the energy company developing the project.

For buyers, in addition to potential energy cost savings, pricing in a PPA contract provides greater predictability for planning, protecting the company against potential future energy rate increases. Micro and small businesses signing PPAs will also gain greater visibility through sustainability, given the potential receipt of renewable energy certificates, combined with proof of greenhouse gas emission reductions and compliance with renewable energy usage targets.

For the project developer, entering into PPA contracts ensures greater revenue stability over a longer term. Furthermore, PPAs allow the energy company to mitigate its risks by diversifying its customer portfolio.

Figure 3 – Financial engineering through PPA and financial trust

Source: Prepared by the author (2022).

The proposal for these two alternative models of financial support for distributed generation projects is based on the lack of effective and viable solutions for operating in a highly complex and challenging market in terms of risk and management. The use of these financing alternatives, combined with the legal innovation of the financial trust, enhances the channeling of resources toward institutions focused on serving micro and small businesses, constituting a very robust model of credit and management solutions.

Final considerations

In the current Brazilian context, the National Development System primarily operates through banking operations, remaining isolated from the capital markets. Therefore, it is desirable for regional development financial institutions to seek appropriate instruments to work in harmony with the capital markets. Mechanisms such as the securitization of credit assets, trusts, and loan guarantee funds constitute highly suitable legal and financial alternatives for strengthening the credit assistance instruments of regional development financial institutions, especially for micro and small business projects.

The analysis indicated that such instruments, if properly regulated and coordinated, have the potential to mitigate risks, leverage resources, and facilitate the entry of new players into the distributed energy market. Furthermore, they stand out as opportunities to strengthen the integration between the national development system and energy transition policies. In this sense, this paper presents a new type of financial engineering that provides better conditions for Brazilian micro and small entrepreneurs to implement distributed renewable energy generation projects, given the observation that the main barriers to the diffusion of this modality in Brazil are related to information, investment, and a lack of appropriate financial products and business models.

Although the models proposed here still require empirical validation and technical development, they offer guidelines for formulating public policies and structuring institutional arrangements capable of expanding the social and economic reach of distributed generation. The articulation of financial innovation, legal certainty, and development policies is a key element in transforming this segment into a relevant vector of sustainable development in the country.

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