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The Interpretation of the Brazilian Regulation of Distributed Generation in the Different States and Electricity Distributors

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Abstract

This article presents the state of the art of distributed generation regulation in Brazil, carrying out a critical study regarding the interpretation of those regulations by electric power distributors (EPD) in the Southeast region of Brazil, pointing out the differences between the connection procedures, the tax charges in the energy tariff, and the TUSD (transmission system use tariff) of customers with DG and the payment of the minimum consumption of 100 kWh. This study portrays how the different views and interpretations of regulation affect the market, both for customers and for companies in the energy business. As support for the assessment will be used energy bills from consumers with distributed generation from three different power suppliers located in the states of Rio de Janeiro, Minas Gerais, and São Paulo. In this way, a more assertive and comparative analysis will be presented, based on the premise of the current regulation of the Brazilian electricity sector in November 2021. As a result, the existence of different interpretations of the regulatory standards between the EPD was verified, highlighting that two out of three studied EPD charge tax on the TUSD portion of the energy tariff, one of the distributors does not inform in its invoice the customer's energy credits and one distributor requires the physical delivery of all documentation necessary for the connection process.

Keywords: Distributed power generation, energy consumption, energy resources, power system economics, power generation economics, electricity supply industry regulation, governmental factors.

1. Introduction

The Brazilian electricity sector has, for many years, presented obstacles to the production of electric energy from micro and mini generators connected to the distribution network. Until 2012 there were only 20 mini / micro-producers connected to the distribution network, as shown in Figure 1.

As the main reason for this fact, there is the complexity of the laws that regulated the sector for the connection of generators to the electric grid aiming at the commercialization of energy, including contractual requirements considering conditions concerning the amount generated. Thus, this type of market ended up being unviable for small producers, causing many to use the resource produced only for their consumption [1].

In April of 2012, with the publication of Normative Resolution N° 482 [2], the National Electric Energy Agency (ANEEL), the regulatory authority of the Brazilian power sector, was responsible for reformulating the matters regarding power generation plants connections in the Brazilian electrical system, which establishes the conditions for the access of microgeneration and mini-generation distributed systems in the power grid, along with other guidelines and responsibilities. After regulation implementation, the number of achievements increased exponentially, reaching 213,390 verified in 2020, as shown in Figure 1. Currently, 833,139 consumer units have distributed generation (DG) and/or receive energy credits generated from DG, totaling an installed power of 7,499.05 GW [3].

In addition to the Brazilian regulatory agency defining the new simplified project standards for interconnections, the restructuring also took place in terms of the tariff regime to which the new category of generators would be submitted. According to [4], a small-scale generation can connect to the grid without being obliged to integrate the energy market by the Electric Energy Trading Chamber (CCEE), unlike other types of generators. For the classification as DG, the regulation does not allow the commercialization of the energy produced. Therefore, the main focus of mini and micro-generators is to supply their consumption. After 2012, the regulation allowed the implementation of an energy credit system, in which the surplus energy produced is accounted for by the power distributor and made available to the generator in a credit format, which is shown on the energy bill itself and has an expiration date of 60 months.

Many of the research lines related to the DG theme usually focus on the technical aspects involved in the new characterization of the distribution systems with the introduction of active elements in different points of the electrical network. This subject arouses interest both at the national and international levels, in [5] he authors reviewed the impacts of DG on protection systems and challenges for voltage regulation with the high penetration of DGs, presenting as solutions intelligent control methods based on power electronics. Still, in this sense, in [6] , the impacts for the energy planning of the electric sector were portrayed, considering the difficulties for the forecast of annual

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reduction of consumption in the substations, calculations of energy losses, and possible violations of voltage.

However, not only technical issues are relevant when it comes to DG modality. Garcez, in [4] sets out to describe the political context surrounding DG in Brazil, evaluating the mechanisms of the current regulation and carrying out an economic approach at the end by using linear regression to demonstrate that the high electricity tariffs are important, once they enable customer's projects and acknowledges that, the application of the state tax, tax on Circulation of Goods and Services (ICMS), harms on the final decision.

In [7], the authors address the scenarios and future perspectives of DG in Brazil, highlighting the different factors that influence their growth, such as increasingly high energy tariffs and the existence of tax incentives, for example. Also, in [8], some gaps in the current regulation of DG are still identified, with an inability for more significant financial incentives, such as the possibility of selling or discount related to the cost avoided by the power supplier caused by the energy surplus being injected by the consumer, as from 1978 in the USA.

In this sense, this article aims to assess how the different interpretations of the current DG regulation in Brazil can affect customers who appreciate this benefit and those who want to. To this end, this piece presents a state-of-the-art description of the current regulation and incentive policies in Brazil, and a brief comparison with the scenario in different countries encouraging DG. It presents a study case where the energy bills of three unrelated consumers are analyzed, connected to three distinct distributors located in the southeastern region of Brazil, to verify the differences between tariffs, taxes, and the process of connection in each of these distributors' concession areas.

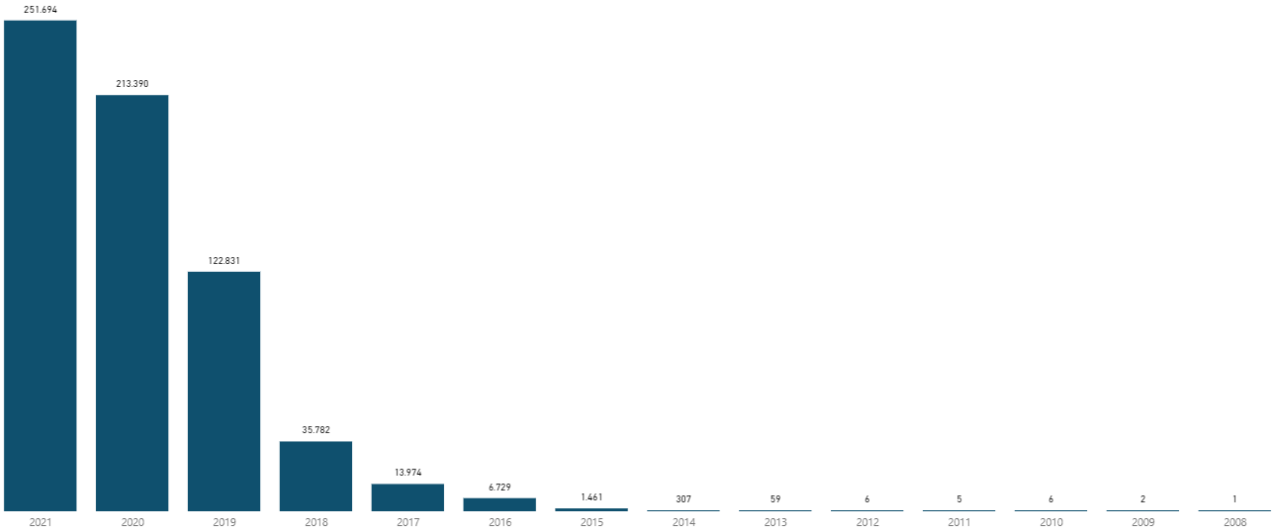

Fig. 1. Annual amount of DG connections [3].

2. Overview DG Regulation Around The World

As mentioned before, DG presents numerous challenges to the power sector, which it is worth to mention the technical challenge associated with the operation of the network and connection of DG to the grid, the proper way to encourage renewable energy generation, and the complexity to formulate a regulatory system that can efficiently and fairly regulate DG.

The following sub-items present the international experiences of some countries concerning the issues mentioned above.

2.1. Latin America

It is worth to mention that Uruguay was the first country in Latin America to adopt a DG policy, where what draws the most attention is that it was possible to sell the energy produced by users for the same amount of kWh charged by the EPD, making possible to generate an extra income with the energy surplus, besides to some tax incentives such as the possibility of exemption from income tax and activities (IRAE), wealth tax, among others [9].

Regarding Mexico, it addresses the issue of mini and micro DG in a very similar way that Brazil does. Small producers are not able to sell the energy surplus produced, and since 2008, Mexico has adopted the energy credit system. However, to connect to the grid, it is obligatory to sign a contract with the Federal Electricity Commission (CFE) [9].

In a similar way to Uruguay, law # 1715/2014 was implemented in Colombia, enabling users to sell their surplus energy to EPD, in addition to dividing them into small-scale (production up to 1 MW) and large-scale (production bigger than 1 MW) [10]. In February of 2018, the Energy and Gas Regulatory Commission (CREG) issued Resolution # 30/2018, which establishes the conditions for the sale of energy surplus to generators that produce up to 5 MW [11].

2.2. Europe

Regarding Europe, it is worth mentioning that Germany, Denmark, and Sweden have decentralized distribution systems with a large number of EPD, which facilitates the connection of more DG units. Besides, Germany and Denmark are among the pioneer countries in promoting the use of sustainable technologies through the payment of a fixed tariff for the injected energy.

Germany is the nation among these, that has the most attractive/desirable connection conditions, where the renewable DG user does not need to fund any expansion of the distribution network, and he has priority connection and access to the grid. Sweden, on the other hand, is the country, among those mentioned, that has less attractive connection conditions, where the EPD have the obligation to connect the generating plants, but are not responsible for the costs of network expansion, falling on the first user who wishes to connect. Therefore, users who do not have DG are most affected in Germany and Denmark, since the costs for the

expansion of the network are divided among all users through changes in energy tariffs [12].

2.3. United States of America

The expansion of DG in the United States is due to several policies, such as federal tax benefits, state incentives, and private financing models. According to the North Carolina Clean Energy Technology Center, 42 states, and the District of Columbia have restructured the laws surrounding DG, such as reducing compensation for the injection of energy into the grid, increasing fixed fees for maintaining the grid (that cannot be compensated), and migration to time-of-use tariffs (TOU), where the price of energy generated varies according to the period of the day [13].

Innovations in financial and business models have proliferated in the United States as a way to obtain political advantages and regional energy prices involving DG. Leading to the implementation of projects such as shared solar systems, the use of third party property, securitization, among others [14].

3. DG Regulation In Brazil

3.1. Historical contextualization

One of the initial milestones for the restructuring process of the Brazilian electrical system was the publication of Law N° 8,987, of February 13, 1995 [15], with the responsibility of public service providers to adapt and improve the service to users. This new model provided changes of an institutional and regulatory nature in the electric sector, being still valuable for the development of the sector [16].

Other law proposals have been made over the years, such as Law Project N° 630 of 2003 [17], which aimed at creating a policy of incentives for renewable energy projects in the country. To this end, a special fund would start to finance research and encourage the production of electricity, considering wind and solar energy as primary sources. However, this critical project did not proceed to implementation due to the rejection of competent authorities. In 2004, ANEEL Normative Resolution N° 77 [18] was approved to reduce tariffs for the use of electrical transmission and distribution systems directed at undertakings with generation from solar, wind, biomass, qualified cogeneration, or hydroelectric in systems less than or equal to 30 MW, representing an advance to incentives for the use of renewable sources.

Only eight years later, more specifically, on April 17, 2012, ANEEL Normative Resolution N° 482 came into effect, providing benefits to small generators. Initially, only generations limited to 1 MW, which used hydroelectric, solar, wind, biomass, or qualified cogeneration sources, would be included in this resolution. Another considerable advance was the implementation of the credit system for the energy surplus, making it possible to use for future compensation of the electricity generated concerning the consumption of the generating unit, with an expiration date of 36 months.

Because of the high degree of consumer adherence in the country, other updates and adjustments took place over the years. It can be mentioned Normative Resolution N° 687 of 2015, which amends Normative Resolution N° 482 and Modules 1 and 3 of the Distribution Procedures - PRODIST, with contributions such as increasing the installed power limit to 3 MW for water sources with less or equal to 5 MW for qualified cogeneration or other renewable sources of electricity, and the extension of energy credits lifespan from 36 to 60 months. Some other criteria were further modified by Normative Resolution N° 786 of 2017, which also fits water sources in the category of installed power less than or equal to 5 MW for distributed mini-generation.

3.2. Normative and Technical Procedures

This topic aims to present the normative and technical procedures related to the DG process in Brazil, providing a succinct overview of current regulations and resolutions related to the topic.

The following subtopics presents the main rules and resolutions.

3.2.1 Normative Resolution n° 414 of 2010

This resolution is responsible for establishing the general conditions for the supply of electricity, encompassing the rights and duties of consumers and companies capable of providing the public electricity distribution service.

Considering that the distributed micro or mini-generation must be connected to the distribution network through consumer unit facilities (UC), the provisions described in Resolution 414 must be respected, this being complementary to those that deal more specifically with DG. As relevant points, it is possible to comment on the definitions of deadlines for the execution of works, the calculation of the client's financial participation, the types of tariff modalities, and billing procedures.

3.2.2. Normative Resolution n° 482 of 2012

This study addresses the electric system analysis of the industries in the MV grid, considering the simulation of the PVDGs exclusively in the LV grid consumers. First, the network base case was simulated without the PVDG.

Normative Resolution N° 482 of 2012 describes the conditions for the access of micro and distributed mini-generators of electric power generating plants that use qualified cogeneration or renewable sources to the electric energy distribution systems. In 2017 it was updated by Normative Resolution N ° 786, being subdivided as follows:

- Distributed microgeneration: installed power less than or equal to 75 kW;
- Distributed mini-generation: installed power bigger than 75 kW and less than or equal to 5 MW.

Another aspect of the document refers to the electric energy compensation system, also known as net metering, in which the active energy injected by the UC with DG is assigned to the distributor through a loan system, after which is compensated according to the consumption of active electrical energy. Only captive consumers can apply for this benefit. As of 2015, energy credits are valid for 60 months and cannot be transferred to another UC unless the UC that previously held the credits is disconnected.

This Normative Resolution also indicates the responsibilities for the adequacy of the measurement system for this new process. For micro-generators, the technical and financial burden relates to the distributor, while for the mini-generation process, adaptation costs are the responsibility of the interested party.

3.2.3. PRODIST - Module 3

Review 7 of Module 3 of PRODIST, in force since 06/01/2017, aims to describe the procedures for accessing the system of distribution of users with characteristics of consumer, generator, distributor, participants in the net metering programs electricity and energy importer or exporter. The document is structured in 8 topics, being

addressed in this work only the sections 3.1 - Access Procedure, 3.2 - Technical and operational criteria, and 3.7 - Contracts and Access of micro and distributed mini-generation.

Throughout section 3.1, the steps and deadlines for the access consultation and access request processes are detailed, including the information that must be contained therein, such as the works of improvements or network reinforcements necessary for the connection of the generating unit. It is also noteworthy that in the studies carried out by the EPD, the criterion of minimum global cost must be considered to define the alternative connection of the generating plant.

Section 3.2 determines the technical criteria for the protection of the installations, operating frequency range, voltage, and power factor, correlating the basic studies of the user's responsibility necessary to make the connection feasible, and further studies may be requested by the distributor.

For those interested in the distributed micro and mini-generation modality, section 3.7 details the steps to enable access, including the information that must be sent by the distributor in response to these requests, in addition to the technical and operational criteria, project requirements, and for operation, maintenance and security of the connection. Besides, it provides the Access Request Form, set out in Annexes II, III, and IV of section 3.7. It is up to the system user to present the necessary information through the annex corresponding to his file.

3.2.4. Others

On September 2 of 2020, It was signed the Provisional Measure N° 998 by the President of the Republic. The main changes that impact the DG market are investments in energy efficiency referred to in art. 1st should prioritize national industry initiatives and products. Also, the costs arising from contracting the generation capacity reserve referred to in art. 3, including reserve energy, containing, among others, administrative, financial expenditures and tax charges, will be prorated among all end-users of electricity from the SIN, including consumers referred to in art. 15 and art. 16 of Law N° 9.074 of 1995, and in § 5 of art. 26 of Law N° 9.427 of 1996, and the self-producers, these only in the portion of electric energy resulting from interconnection to the SIN, according to regulation [19].

It is remarkable that, in addition to the procedures of regulators in the electricity sector, there are the technical and constructive norms and standards for each distributor accessed, which establish the access conditions and technical criteria that must be respected by the consumer units to ensure that both systems, after the connection, operate safely, ensuring the reliability and quality of electricity.

3.3. Tariff Structure

According to the ANEEL Thematic Booklet - Micro and Distributed Mini-generation with a focus on Electric Energy Net Metering [20], published in 2014, federal and state taxes and levies were collected on energy tariffs are the exclusive competence of the Federal Revenue of Brazil and State Finance Secretariat. The main taxation are related to ICMS and Social Integration Program (PIS) / Contribution for Social Security Financing (COFINS).

Through the agreement, ICMS 16 [21], of April 22, 2015, the National Council for Farm Policies (CONFAZ) authorized Brazilian states to grant exemption from ICMS on electricity supplied under the terms of the net metering of the Normative Resolution N° 482/2012. Previously, with ICMS Agreement N° 6 of 2013, the ICMS rate should be levied on the energy consumed monthly, disregarding the compensation of electrical power produced by the micro or mini-generator.

According to Art. 8 of Law 13.169 of October 6 of 2015, the contribution rates are reduced to zero for the PIS and of the COFINS that are levied on the active power supplied by the distributor, which corresponds to what the UC injects into the distribution network plus the credits of active energy originated by it.

According to ANEEL, the UC currently connected to the low voltage that has DG does not pay all components of the supply tariff on the portion of consumed energy that is offset by the injected power. [23].

In January 2019, ANEEL authorized the opening of Public Hearing N° 1/2019 and, in October 2019, the opening for public consultation in continuity to Public Hearing N° 1/2019 to receive contributions to the proposed revision of the Normative Resolution 482/2012.

The EPD claim that the current energy net metering does not adequately remunerate the use of the distribution network. The review proposes changes in this compensation format so that the costs related to the use of the distribution network and the charges are paid by consumers who have DG. The proposal provides a transition period for changes. Owners who own the mini and micro-generation system will remain with the billing rule in force until the year 2030. Consumers who place an order for the DG installation after the publication of the standard (scheduled for 2021) will now pay the cost of the network (TUSD Fio B referring to the use of the distributor network and TUSD Fio A referring to the transmission network). In 2030, or when a predetermined amount of DG is reached at each distributor, these consumers start to offset the energy component of the Energy Tariff (TE), and in addition to the network costs, the promissory [23]. In this scenario, the consumer with DG would pay all installments of the kWh value, except for the energy tariff, which is the value of the purchase of net energy consumed. The sum of the portions of TUSD wire B, TUSD wire A, losses, and charges of the energy rate is equivalent to 63% of the value of kWh, in this way, DG would compensate only 37% of the total amount of the energy bill [24]. According to companies working in the sector, the payment of these installments will make the application of DG in the remote consumption model unfeasible, since the return on investment will pass to 26 years [25], thus causing a setback in the growth of the DG sector.

4. Study Case: Comparative Analysis Of Regulation From The Viewpoint Of Southeast EPD

Despite the existence of the rules and regulations for DG, and the presence of the regulatory agent ANEEL, Brazilian EPD, do not interpret and cohesively apply the rules and regulations. To exemplify these differences, energy bills from customers with DG from three different EPD, located in the southeastern region of the country, were studied. Table 1 shows the location of EPD, their names, and customers. However, their identity will remain confidential because the purpose of this article is to inform and not to expose.

Table 1. Distributors used in the case study and its location.

Distributors	State	Client
Distributor A	Rio de Janeiro (RJ)	Client 1
Distributor B	Minas Gerais (MG)	Client 2
Distributor C	São Paulo (SP)	Client 3

The customers regarding this study case use the remote consumption system, which is, the generating plant is physically located in one UC, and other UCs consume the energy credits. The generating plant is connected to the medium voltage, and the consuming units of the energy credits are connected at low voltage. All UCs have the same CNPJ or are characterized as a branch/headquarters.

The first divergent point is how the information is presented on customers' energy bills.

The invoices that most clearly demonstrate all information regarding DG credits to the consumer are the invoices from EPD A and B. As noted in Figure 2 and Figure 3, the invoices from these EPD explicitly show the number of energy credits allocated at UC, and they also have the balance of credits available to the UC.

Distributor C's invoices do not clearly show the information concerning energy credits, does not even inform the number of credits generated in kWh, only exposing the amount in reais referring to energy credits, making it difficult for consumers to verify the balance.

Consumer unit in the energy compensation system

Micro/Mini-generation	kWh
Injected energy on the cycle	0
Total credit balance	75.390

Fig. 2. Credit balance tracking table for customer 1 connected to distributor A.

General Information

CURRENT GENERATION BALANCE: 128,00 kWh not critical peak pricing; 2.107,00 kWh critical peak pricing.

Current rate according to ANEEL Resolution n° 2.396, of 05/22/2018.

To the registered values, 2.5% of transformation losses should be added.

Consider paid after debiting your checking account.

The payment of this account does not settle previous debts.

For previous debts, current legal penalties (fines) and / or financial updating (interest) are subject to their due date.

It is the consumer's duty to keep the registration data always updated and to inform changes of the activity performed at the place.

Reading performed according to billing calendars JUL / 2018 red flag 2 - AUG / 2018 red flag 2.

Fig. 3. Credit balance tracking table for customer 2 connected to distributor B.

The second divergent point is the collection of ICMS in the portion of TUSD's electricity tariff.

Distributor A divides the tariff into 5 components: electricity (referring to 100 kWh of availability cost in cases where the generation was equal to or greater than the consumption of the month), injected energy TUSD, and energy supplied TUSD (referring to the cost of the use of the distribution network), injected energy TE (the portion of the power generated that will be offset in the month) and energy supplied TE (referring to the cost of energy consumed from the distributor's network). The tariff used for charging electricity (availability cost) is the full tariff, with all taxes included. The tariff used to calculate the injected energy TE and the tariff for the energy supplied TE (which is the energy that the UC consumed from the grid) have the same value. The TUSD injected energy tariff has no ICMS tax, and the TUSD supplied energy tariff has ICMS. Table 2 represents an example of an invoice from a customer of this distributor that consumed and generated 1,000 kWh. The base rate for the month of August 2018 was used.

Distributor B does not charge ICMS on any portion of TUSD in case the generation is equal to or greater than consumption, regarding that, the customer will only afford the amount referring to the 100 kWh of availability cost. If customer 1 was connected to distributor B, according to Table 2, it would only pay R$ 99.92.

For distributor C, the values of taxes are computed on the value of the energy generated minus the value of the energy consumed from the network. For the calculation of PIS and COFINS, the sum of TUSD and TE is used. For the estimate of the ICMS, only the TE is considered.

The calculations of the components of the tariff are defined by the Secretariat of Finance and can be verified in the legislation of Confaz N° 16/2015, which specifies the exemption from ICMS on TUSD and in law N° 13,169, of October 6, 2015, which deals with the calculation of the exemption of PIS and COFINS on energy generated by DG.

According to Normative Resolution N° 687, in the billing of the UC that is part of the electric energy net metering, at least the amount referring to the cost of availability for the group consumer, amount referring to 100 kWh.

Therefore, the valuation of the energy produced by the DG is different in each of the EPD presented in the study. While distributor A divides the energy portions into TUSD and TE and charges ICMS on the TUSD of the energy consumed from the network, distributor B does not differentiate between TE and TUSD and does not charge ICMS on any portion of the TUSD. Distributor C values the energy generated by the DG equally and the power consumed directly from the concessionaire's network.

Therefore, different from the discourse of some EPD and the motivation presented for the revision of Normative Resolution N° 482, customers with DG do pay for the use of the network (as we see customers 1 and 3 who pay TUSD).

The third divergent point is the process of requesting a connection from the DG to the distributor. Distributor A requires that all technical documentation be delivered in print, either in person at the dealership's office or by mail. At distributor B the documentation is sent by the virtual agency. At distributor C, the documentation is sent by email.

Table 2. Components values of the energy tariff from distributor a.

The Portion of energy tariff	Amount (kWh)	Installment tariff amount (R$)	Amount to be paid (R$)
Power Energy	100	0.99917	99.92
Power Injected - TUSD	1,000	0.30564	-305.64
Power Injected - TE	1,000	0.46962	-469.62
Power Supplied - TUSD	1,000	0.44947	449.47
Power Supplied - TE	1,000	0.46962	469.62
Total Amount			243.75

5. Conclusion

The publication of Normative Resolution N° 482 enabled a great advance for the DG market in Brazil, representing an increase in connections from consumer units with DG of 93% in 2013. The market was further consolidated with the publication of Resolution N° 687 in 2015 and N° 786 of 2017.

When comparing to pioneering countries like Germany and Denmark, Brazil still has a lot to do in terms of its tax incentives and regulation. However, when compared to the United States and other Latin American countries, we can consider Brazilian regulation as an example, since it has adapted over time to market demands and has been inspired by the pioneer countries for improving DG regulation.

Despite the existence of normative resolutions and the regulatory body, the DG market in Brazil still does not work cohesively. Significant differences are observed in the interpretation and application of regulation by different EPD in the country.

As presented in the case study, there was a difference in the way EPD present data and information on customers' energy bills. Another point is the divergence in the collection of ICMS in the TUSD portion of the tariff. Some EPD open this portion of the tariff, and others do not. The third point noted is the difference in DG's connection process. At the EPD in Rio de Janeiro, it is necessary to take the printed documents to the office (or send the printed documents by mail). At the Minas Gerais distributor, the process is done through the virtual agency. At the São Paulo distributor, documents are delivered via e-mail.

Many other procedures differ between the EPD and which were not covered in this article, such as the duration of the process, from the request for access to the connection, the share of the client's financial participation in the network adaptation works, etc. The document [26] shows that the lack of standardization among the EPD is known to the regulatory agency. This lack of standardization affects customers who may have consumer units in different states and professionals working in the area. There is a need for work so that there is a standardization of procedures and interpretation of the regulation, which must be one.

References

1. J. M. Rondina, L. Martins Neto, and M. B. Alves, "Alternative Technology to Enable Distributed Generation," Ieee Lat. Am. Trans., vol. 14, no. 9, pp. 4089–4096, 2016, doi: 10.1109/TLA.2016.7785938.
2. ANEEL, Resolução Normativa No 482. Brasil, 2012, p. 12.
3. ANEEL, "Micro e Minigeração Distribuída (REN 482/2012)." https://www.aneel.gov.br/outorgas/geracao/-/asset_publisher/mJhnKIi7qcJG/content/registro-de-central-geradora-de-capacidade-reduzida/655808?inheritRedirect=false&redirect=http%3A%2F%2Fwww.aneel.gov.br%2Foutorgas%2Fgeracao%3Fp_p_id%3D101_INSTANCE_mJhnKIi7q (accessed Nov. 01, 2021).
4. C. Gucciardi Garcez, "Distributed electricity generation in Brazil: An analysis of policy context, design and impact," Util. Policy, vol. 49, pp. 104–115, 2017, doi: 10.1016/j.jup.2017.06.005.
5. S. E. Razavi et al., "Impact of distributed generation on protection and voltage regulation of distribution systems: A review," Renew. Sustain. Energy Rev., vol. 105, no. May 2018, pp. 157–167, 2019, doi: 10.1016/j.rser.2019.01.050.
6. P. De Lima Vianna, M. Sabino Viana, G. M. Junior, and M. Edgar Morales Udaeta, "A General Analysis of the Distributed Generation Impact on Electrical Energy Planning," Proc. - 2018 53rd Int. Univ. Power Eng. Conf. UPEC 2018, pp. 18–23, 2018, doi: 10.1109/UPEC.2018.8542020.
7. V. C. D. Assad and O. E. Batista, "Scenario and perspective of distributed generation in Brazil," SBSE 2018 - 7th Brazilian Electr. Syst. Symp., pp. 1–5, 2018, doi: 10.1109/SBSE.2018.8395706.
8. M. Kawai, A. V. Soares, P. F. Barbosa, and M. E. M. Udaeta, "Distributed generation in Brazil: Advances and gaps in regulation," IEEE Lat. Am. Trans., vol. 13, no. 8, pp. 2594–2601, 2015, doi: 10.1109/TLA.2015.7332137.
9. F. Santamaria, J. Hernandez, and C. L. Trujillo, "Regulation on distributed generation: Latin American Case," 2014 IEEE PES Transm. Distrib. Conf. Expo. PES T D-LA 2014 - Conf. Proc., vol. 2014-Octob, 2014, doi: 10.1109/TDC-LA.2014.6955274.
10. R. Ferreira, P. H. Corredor, H. Rudnick, X. Cifuentes, and L. Barroso, "Electrical expansion in South America: Centralized or distributed generation for Brazil and Colombia," IEEE Power Energy Mag., vol. 17, no. 2, pp. 50–60, 2019, doi: 10.1109/MPE.2018.2884113.
11. Comision de Regulacion de Energia y Gas CREG, "Resolución No. 30 de mayo de 2018," Mme. p. 13, 2018, Online.. Available: http://apolo.creg.gov.co/Publicac.nsf/1c09d18d2d5ffb5b05256eee00709c02/83b41035c2c4474f05258243005a1191/$FILE/Creg030-2018.pdf.
12. K. L. Anaya and M. G. Pollitt, "Integrating distributed generation: Regulation and trends in three leading countries," Energy Policy, vol. 85, pp. 475–486, 2015, doi: 10.1016/j.enpol.2015.04.017.
13. T. Lowder, E. Zhou, and T. Tian, "Evolving Distributed Generation Support Mechanisms: Case Studies from United States, Germany, United Kingdom, and Australia," Natl. Renew. Energy Lab., no. March, 2017, [Online.. Available: https://www.nrel.gov/docs/fy17osti/67613.pdf.
14. T. Lowder et al., "Historical and Current U . S . Strategies for Boosting Distributed Generation Historical and Current U . S . Strategies for Boosting Distributed Generation," no. August, 2015.
15. Presidência da República - Casa Civil, "Lei n° 8.987, de 13 de fevereiro de 1995," 1995. http://www.planalto.gov.br/ccivil_03/leis/l8987compilada.htm (accessed Aug. 29, 2020).
16. M. A. I. Martins, R. Fernandes, and M. L. Heldwein, "Proposals for Regulatory Framework Modifications for Microgrid Insertion-The Brazil Use Case," IEEE Access, vol. 8, pp. 94852–94870, 2020, doi: 10.1109/ACCESS.2020.2991961.

17. Assembleia Legislativa, "Projeto de Lei 630/203." https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=109513 (accessed Aug. 29, 2020).
18. ANEEL, "Resolução Normativa N° 77." p. 8, 2004, Online.. Available: http://www2.aneel.gov.br/cedoc/ren2004077.pdf.
19. "MEDIDA PROVISÓRIA No 998, DE 1o DE SETEMBRO DE 2020," 2020. http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2020/Mpv/mpv998.htm (accessed Sep. 05, 2020).
20. ANEEL, "Procedimentos de Distribuição de Energia Elétrica no Sistema Elétrico Nacional - PRODIST Módulo 2 - Planejamento," Cad. Temáticos ANEEL, p. 34, 2016, Online.. Available: http://www.aneel.gov.br/modulo-2.
21. CONFAZ, "ICMS 16, de 22 de abril de 2015," 2015. https://www.confaz.fazenda.gov.br/legislacao/convenios/2015/CV016_15 (accessed Sep. 07, 2020).
22. Presidência da República - Casa Civil, "Lei 13.169, de 6 de outubro de 2015," 2015. http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13169.htm (accessed Sep. 07, 2020).
23. "Revisão das regras de geração distribuída entra em consulta pública - Sala de Imprensa - ANEEL." https://www.aneel.gov.br/sala-de-imprensa-exibicao/-/asset_publisher/XGPXSqdMFHrE/content/revisao-das-regras-de-geracao-distribuida-entra-em-consulta-publica/656877 (accessed Sep. 13, 2020).
24. "Micro e Minigeração Distribuída: Proposta em Audiência Pública - YouTube." https://www.youtube.com/watch?v=BuMRgS0Bmp8 (accessed Sep. 13, 2020).
25. "ANEEL anuncia proposta desastrosa para o setor solar e surpreende o mercado." https://canalsolar.com.br/noticias/item/179-aneel-anuncia-proposta-desastrosa-para-o-setor-solar-e-surpreeende-o-mercado (accessed Sep. 19, 2020).
26. F. Krenz, Peter; Teivelis, "Redução de Barreiras Para a Instalação de Geração Distribuída de Pequeno Porte, a Partir de Fontes Renováveis, Conectada em Tensão de Distribuição," 2015. http://www2.aneel.gov.br/arquivos/PDF/Proc. 48500.004924-2010-51 - Vol.09.pdf%0A.