Achieving retail liberalization in middle-income countries: The Brazilian Experience

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Electricity market liberalization initiatives have swept the world since they were first proposed and thoroughly studied in the 1980s, finding significant buy-in from middle-income countries. Many of these countries embarked in the wave of electricity liberalization in the 1990s following the United Kingdom's (UK's) market reform and have, as of today, successfully implemented wholesale competition. Generally speaking, most middle-income countries have interrupted the process before reaching full retail liberalization, and thus, consumer choice is still mostly restricted to industries. The technological and social advances of decarbonization, decentralization, and digitalization have brought back the full retail liberalization agenda so that consumers can be empowered to freely select their own supplier, type of energy, and hence be active players in the power market.

The core challenges of retail liberalization that policymakers need to tackle are well known – among which it is possible to highlight:

- increasingly active clients of all consumer classes
- novel business models
- growth of distributed energy resources
- the need to accommodate new types of agents
- ensuring a fair treatment of both newcomers and already-existing players

Middle-income countries in particular face all of these challenges while also facing a high proportion of socially and economically vulnerable consumers, relatively young institutions, and immature marketplaces for hedging against risks and/or procuring financing. In addition, "legacy" costs from the reforms of the 20th century may impose further challenges to liberalization.

Brazil in particular is a fascinating case study. The country has historically relied on large-scale centralized generation (mostly hydropower), but recently has seen increased initiatives for distributed energy resources, highlighting the fundamental role of consumer choice in the electricity market. As a consequence, retail liberalization is being discussed in the country via legal and infra-legal pathways. In this article, the Brazilian conjuncture, constraints, and successes along the way towards retail market liberalization are used as a backdrop for a broader discussion that can apply to a range of middle-income countries facing similar challenges.

1 Highlights of the Brazilian context and retail liberalization

This section introduces the Brazilian regulatory context, existing initiatives towards full retail liberalization, and the options available to smaller "regulated consumers" that allow them to de facto choose a supplier to some extent. Finally, we draw attention to the socioeconomic complexities of the country as an important background for the challenges faced.

1.1 Recent liberalization efforts in place

Large Brazilian consumers may opt to participate in the free market and have freedom to choose their suppliers – in contrast, "regulated consumers" must be supplied by the concession holder in the area where they are located (i.e., the distribution companies or Distcos). The Brazilian free market accounts for 35% of the country's consumption and is currently fully accessible to consumers who have a peak load of at least 1 MW. Special rules exist that apply for consumers with a peak load of at least 0.5 MW who purchase energy from nonconventional renewable generation sources (wind, solar, small hydros, and bioenergy – known as "incentivized energy,"). From January 1, 2024, onwards, the free market will be expanded, and any consumer connected to the system at a voltage level of 2.3 kV or more will be eligible to access it and hence bilaterally negotiate its supply contracts, from any source. Consumers may always choose to continue to be supplied by regulated tariffs in a distribution company if they prefer.

In 2022, a Public Consultation was launched proposing full retail liberalization – that is, encompassing the segment of low voltage consumers, connected at voltage levels below 2.3 kV. According to this proposal from the Ministry of Energy, most low-voltage consumer classes (including commercial services and public services) would be able to opt for the free market from January 1, 2026, while rural and residential consumers would also have access to this choice from January 1, 2028. A Bill – number 414/2021 – is also being discussed in the Brazilian parliament for the same purpose. Government institutions have shown with these initiatives that they are indeed committed to the idea of liberalization – while at the same time conceding that there are obstacles that will need to be surmounted, particularly with regards to the level of cross-subsidies and distortions currently present in the Brazilian electricity sector.

The topic of full retail liberalization has been under discussion in Brazil since at least 2015, in line with international trends of consumers becoming increasingly aware of their electricity management. Indeed, even in the context of the regulated market, consumers have been empowered to make some level of choice with regards to electricity supply, which has been used as an argument for full retail liberalization in the discussions. The options available to regulated consumers are discussed next.

1.2 Regulated consumers being not so regulated

Even though regulated consumers cannot choose their retailer, over the years the rules governing this market have provided regulated consumers menus of options they could choose from, representing some level of "de facto" liberalization. Coupled with technological advancements and cheaper control equipment, these regulatory initiatives have been enabling regulated consumers to arbiter between the regulated tariff and other supply options.

The first layer of freedom that regulated consumers have is to play with the tariff structure. As illustrated in Table 1, low-voltage consumers can opt for the conventional tariff (flat) or for the "white" tariff (peaked); whereas high-voltage consumers can opt for the "blue" tariff (flat) or for the "green" tariff (peaked). More accurately, only medium-voltage consumers up to 69 kV have the choice between the "green" and the "blue" tariff (not all high-voltage consumers), and the "blue" tariff is in fact not quite "flat" (though significantly "flatter" in nature than the "green" tariff). These available choices are, in essence, standard time-of-use tariff designs, which should allow consumers

that have a greater propensity to respond at peak hours to opt-in, while shielding consumers that are not interested.

Table 1 – Summary of Brazilian tariff structures and time-of-use incentives (Source: authors)

Voltage level	Name of tariff mode	Nature of tariff mode	Typical per-kWh tariff ratio: peak VS off-peak
Low-voltage	Conventional	"Flat"	1
	"White"	"Peaked"	2
High-voltage (Medium-voltage)	"Blue"	"Flat(ter)"	1.5
	"Green"	"Peaked"	6

A direct consequence of the time-of-use tariffs is that consumers will follow the incentives set by the mechanism – and either change their behavior or invest in new assets in a way that makes financial sense for them. The magnitude of the incentive implied by the "green" tariff is so high that it has often been profitable for medium-voltage consumers to maintain a generator on site to dispatch it during the peak hours. The associating fixed costs of this investment can be fully covered by the difference between the "green" tariff and the fuel cost of operating the generator during peak hours for its entire useful life. The green tariff design brings distortions that should be eliminated as the country revisits its tariff structure framework. A silver lining is that tariff distortions have created a culture that may facilitate the dissemination of new distributed energy resources among these medium-voltage consumers in the context of the energy transition. Economics today usually favor diesel-fired generators, but battery storage systems have proved competitive in some cases.

Finally, the most relevant case in which regulated consumers have a choice are small-scale distributed generation (DG) arrangements. Regulation introduced in 2012 allows clients to benefit from a net metering subsidy (paying the Distco a volumetric tariff only in proportion to their net consumption) in case they have a DG installation in their own consumer unit, or if they adhere to a consortium of consumers who deploy these units elsewhere within the concession area of its Distco. The market for distributed generation in Brazil has been booming since around 2016, when it started to become economically attractive for low-voltage consumers to purchase a small-scale rooftop solar system rather than paying the distribution company tariff. Such installations have been more than doubling each year since, as illustrated in Figure 2: distributed solar capacity has surpassed utility-scale installations by over 100%, reaching over 15,000 MW installed.

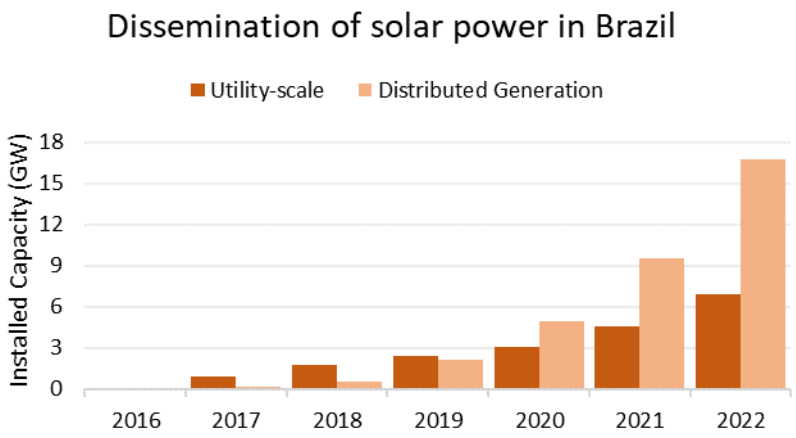

Figure 1- Evolution of cumulative solar installed capacity in Brazil. 2022 data refer to installed capacity at the end of October (Source: authors)

These initiatives highlight the variety of options the regulated Brazilian electricity consumers already have given the limited amount of choice available to them – which are made possible by consumers' resourcefulness, but also by the economic incentives and distortions imposed by the regulation. However, if economic incentive is miscalculated, market imbalances can emerge – a topic that will be addressed next.

1.3 Socioeconomic complexity is an issue

Brazil has 54 major electricity distribution companies (distribution concessions or Distcos), comprising 88 million consumers, 530 TWh of total demand, and 3.8 million kilometers of distribution network. As highlighted earlier, Distcos operate as retailers for around 65% of the Brazilian electricity market.

Distcos are very heterogenous, especially in terms of market size, population density, and socioeconomic conditions. Households with average income less than roughly US$ 120 per capita per month (half of the country's minimum wage) represent 27% of the country's population on average, reaching 50% in the poorest states. Low-income households benefit from the "social tariff" program, which lowers their power bills by up to 60%.

In addition to household income levels, also areas exist in which the social environment is institutionally disorganized, and the state has difficulty providing public services and security. This anomie environment has particularly impacted Distcos' energy theft levels, as shown in Figure 2, that shows energy theft can vary from less than 5% to more than 100% of low voltage formal consumption, depending on the region and concession.

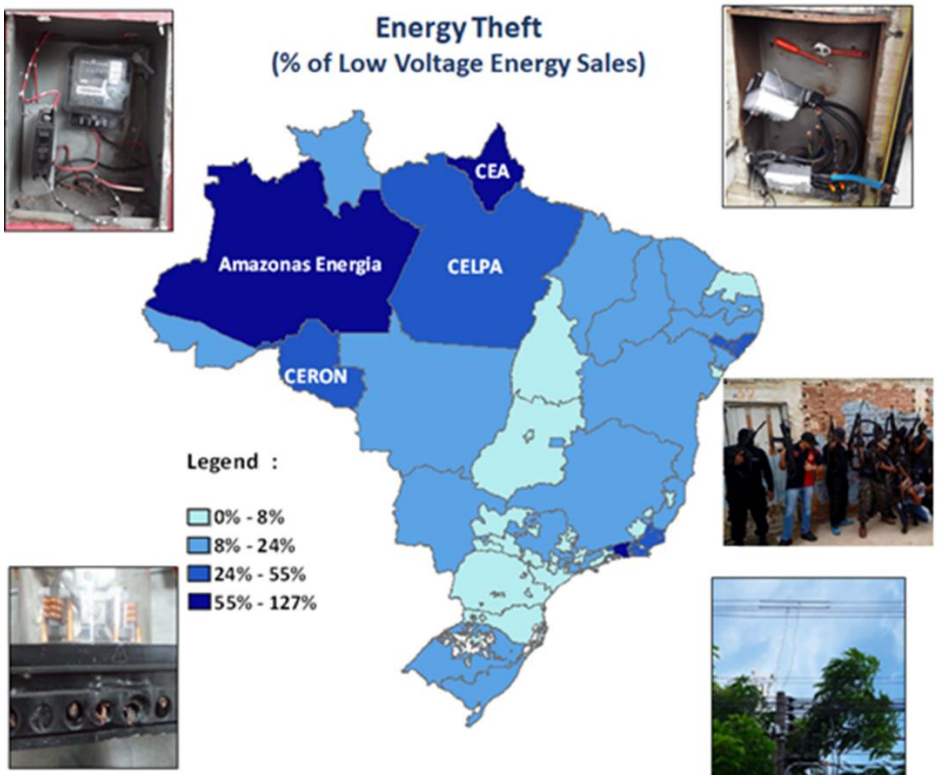

Figure 2- Concession areas of the most important Brazilian Distcos, highlighting average energy theft levels (Source: authors).

Electricity theft and income levels are relevant indicators of Brazilian socioeconomic complexity, which must be taken into consideration when designing and evaluating new regulatory and market trends related to retail liberalization. In addition, the fact that concessions are very different from one another requires a more flexible regulatory framework to better accommodate heterogeneities.

2 Challenges to full-retail liberalization

This section addresses key financial "legacies" of the electricity sector in Brazil that might make the transition towards a full retail liberalization more challenging. While the particulars of these so-called "legacies" can differ from country to country, the resulting distortions can make it more challenging to find a healthy balance in the retail market once full liberalization is introduced.

2.1 Legacy contracts and the cost of purchasing reliability

Brazil has a legal obligation that all electricity consumption, whether in the free or in the regulated market, must be backed by energy purchase contracts, and these contracts must in turn be supported by physical energy generation facilities (measured by a firm energy certificate). Based on this rule, the procurement of a new power generation project in Brazil is done in two ways: (i) centrally, through regulated auctions organized by the government, in which distribution companies purchase energy contracts to meet the growth of regulated consumers' consumption; and (ii) in a decentralized way, as the result of bilateral negotiations between sellers and buyers on the free market.

Even though new generation capacity based on free market contracts has been an increasing presence in the Brazilian market, for several decades the regulated market has been one of the major drivers of system expansion. The Distcos themselves are responsible for setting the demand for the centralized auctions, but it is up to the government to determine which types of contracts (and/or products) will be offered, what generation sources will be able to participate, and what the ceiling prices will be. Thus, the government has used these technology-specific auctions to procure the kind of new generation supply that will bring desirable "attributes" to benefit the system as a whole, even if costs of some auction winning technologies are higher than others.

Therefore, whereas buyers of electricity in the free market will typically purchase electricity exclusively from the least-cost options available (typically solar and wind), Distcos in the regulated market will often end up purchasing a costlier mix of technologies because of the auction design. Because of this practice, the average cost of contracts in the regulated market (passed through to regulated consumers via electricity tariff) has been trending much higher than contracts in the deregulated market – as illustrated in Figure 3 below.

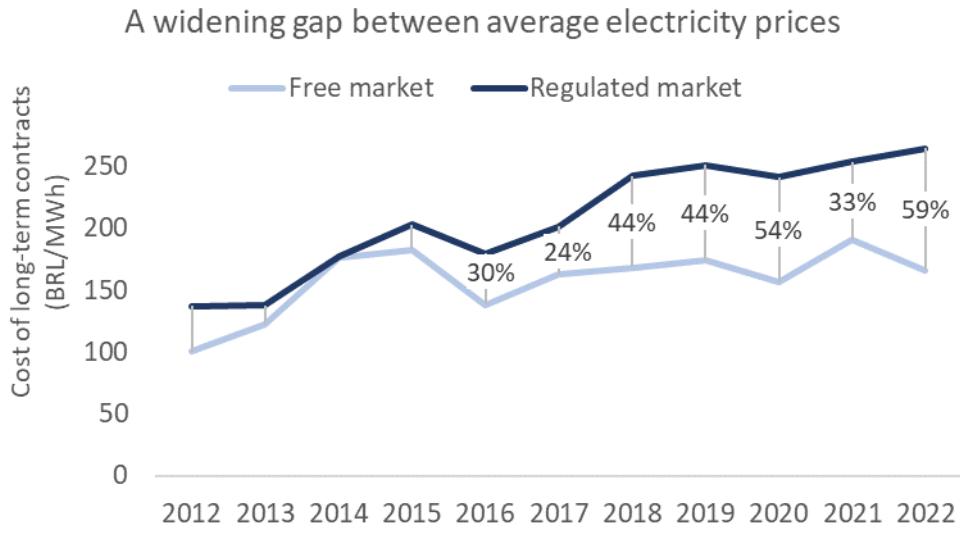

Figure 3- Historical average electricity prices for contracts in Brazil's free market and energy purchase costs in the regulated markets. (Source: authors). 1 USD = ~ 5 BRL.

In addition, to facilitate the process of obtaining financing from financial institutions, the contracts offered for new supply in regulated auctions have long duration (typically 15 to 30 years). Because these long-term contracts are take-or-pay for the generators (the Distco assumes the consumption risk), Distcos are vulnerable to having excess contracts in their portfolio in case of a mass migration of consumers to the free market. Regulated consumers will thus tend to be saddled both with the higher costs of energy purchases and the costs of Distcos's excess contracts.

This situation is a major flaw in the market design that creates a free-riding behavior for consumers that migrate to the free market (if they are regulatorily able to) or that adopt distributed generation. It is especially a moral and social concern as it disproportionally burdens residential consumers and small businesses that are more likely to remain in the regulated market. More recently, last-resort contract auctions and capacity reserve auctions with costs borne by all consumers were introduced

as a step in the right direction to start fixing this flaw, despite the still standing legacy cost of reliability assigned only to the regulated market.

2.2 Legacy incentives and tariff distortions

This section will introduce Brazilian legacy energy policy mechanisms that effectively reduce certain consumer categories' cost of electricity. This type of policy can be justified in certain cases: in Brazil, these subsidies have been responsible for the dissemination of renewable sources (as "incentivized energy"), distributed generation, and also for mitigating social issues via social tariff programs. Nonetheless, concerns exist that regulatory decisions made under different conjunctures may become misaligned with the current system reality.

The table below illustrates how specific business models can benefit from distortions and arbitrages in Brazil (each of these business models highlighted in the columns will be described next). The table summarizes the net effect of complex tariff interactions that relate to the following tariff components (paid to the Distco by both free and regulated consumers):

- The "TUSD-D" component represents the costs of remunerating the transmission and distribution ("T&D") networks in Brazil and will be referred to in this article simply as "T&D costs." This component tends to be substantially greater among low-voltage consumers (around two times greater on average). In addition, whereas low-voltage consumers always pay for these costs on a per-volume basis ($/MWh), high-voltage consumers will tend to pay for most of these costs on a basis of peak demand ($/kW.month).
- The "TUSD-E" component is referred to as a "Charges" component that includes various types of cost component that are typically charged on a per-volume basis ($/MWh) and that also tends to be higher for low-voltage consumers. A major contributor to this component is the "Energy Development Account" which is the country's fund to recover costs associated with various cross-subsidy programs. Another cost component relates to the Distcos' "efficient" loss levels (technical and non-technical in nature).

Table 2 – Examples of tariff arbitrages and distortions in Brazil (Source: authors)

Expected proportional tariff reduction		**Regulated market**		**Free market**	
		Distributed generation	**Green tariff self-supply**	**Incentivized energy**	**Outside-the-fence self-production**
Low-voltage	**T&D costs** (TUSD-D)	**High**	**N/A**	**Medium-High***	**None***
	Charges (TUSD-E)	**High**	**N/A**	**None***	**Medium-High***
High-voltage	**T&D costs** (TUSD-D)	**None**	**Medium-Low**	**Medium**	**None**
	Charges (TUSD-E)	**High**	**None**	**None**	**High**

* Currently inaccessible (until retail liberalization reaching low-voltage consumers)

In the case of distributed generation, consumers only need to pay the Distco in proportion to their net consumption (i.e., the difference between energy imported from and exported to the grid), regardless of the hourly profile of these electricity flows. As a consequence, they can effectively

avoid paying any costs that are charged on a R$/MWh basis by the Distco (which is why the "Charges" component for both low-voltage and high-voltage consumers, in addition to the T&D costs for low-voltage consumers, are represented as a "High" subsidy in Table 2). Law No. 14300 from January 2022 brought changes to the net-metering mechanism aiming to reduce this tariff distortion over time (in particular for the T&D components) – however, the phaseout of the incentive will be gradual over the next ten years, with existing projects retaining the current level of benefits until 2045. It is worth noting that, starting in 2023, this subsidy to adopters of distributed generation will be incorporated explicitly into the "Energy Development Account" (part of the "Charges" component) as a cross-subsidy.

In the case of the green tariff self-supply route, a portion of the T&D cost component is translated into a premium (in R$/MWh) that is added to the cost of electricity at peak hours. As discussed earlier, this premium tends to be so high that many adopters end up maintaining a diesel generator "behind the meter." Furthermore, the premium is calculated by assuming a predefined capacity factor at peak hours. The net effect is that, by operating such a generator, consumers end up not paying for a portion of the associated costs of the transmission and distribution network (though this is a "Medium-Low" subsidy proportionally).

The "incentivized energy" subsidy is a legacy incentive to renewable generators established 25 years ago in the form of a 50% discount in the T&D tariff component of both the sellers and the buyers of electricity from "incentivized sources." When the law was originally enacted, the economic viability of these sources was profoundly different from today, and the free market (eligible for this tariff discount) was constrained to a much smaller pool of consumers. Consumers connected to the low-voltage grid are not only much more numerous, but they also have much higher T&D tariff components in absolute terms. As a consequence, as the free market expands, this subsidy could grow significantly – with its costs incorporated into the "Charges" tariff component.

Another opportunity that consumers can take advantage of to avoid certain electricity sector charges is the so-called "self-production" arrangement. In Brazil, it suffices for a consumer to be the shareholder of power plants that do not need to be located on the consumption site to be exempted from a significant portion of the "Charges" component (including cross-subsidies relating to the costs of the "incentivized energy" and, starting in 2023, of the "distributed generation" program). More recently, a special juridical structure has allowed consumers to profit from this benefit even without a capital commitment on the generation plant.

2.3 Consequences and concerns of existing cross-subsidies

Concerns with the potential cost imbalances of the subsidies described earlier have been raised. They create regulatory risk-free arbitrages, backed by the co-existence of different incentives perceived by consumers that may stimulate migration to the free market for reasons other than simply the market price and better services by the supplier. Perhaps most importantly, increasing rates of adoption tend to create a positive feedback loop, in which a larger number of adopters to the free market leaves a smaller number of consumers to pay for the costs left behind, which in turn increases tariffs and incentivizes further migration. These feedback loops are especially concerning when considering that, even in the context of a full market liberalization, most likely it will be smaller and lower-income low-voltage consumers that can be expected to have the greatest level of difficulty in making this migration, requiring them to absorb much of the resulting price shock.

Figure 4 illustrates how key subsidy components have been growing over the past few years. The increase in the distributed generation component results from the exponential growth of DG, whereas the incentivized energy component is largely associated with the migration of consumers to the free market. With further retail liberalization, room exists for the incentivized energy subsidy to grow even more. The biggest issue here is not necessarily with the existence of these subsidies, but with facilitating access to existing arrangements to broader groups of consumers with higher tariff components, without concern for the effect on consumers that remain in the regulated market.

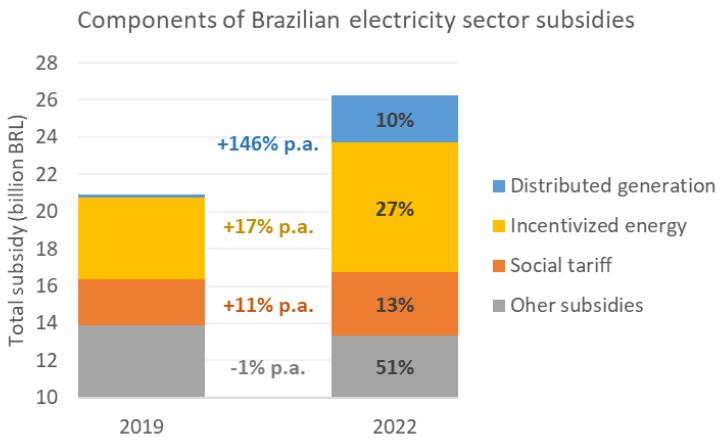

Figure 4- Comparison of total subsidies in the Brazilian electricity sector in 2019 and 2022, highlighting key relevant components. (Source: authors) 1 USD = ~ 5 BRL.

3 Despite challenges, the march to retail liberalization moves on

The abovementioned distortions show a potential risk of mass migrations to the free market or DG in a disorganized way due to risk-free regulatory or tariff arbitrages. This situation has resulted in a consensus in the country that it is important to organize and move forward with an organized market liberalization. The issues that will need to be solved to enable a sustainable process are profound, with no clear-cut solution in sight. Despite this difficult context, Brazil has been able to accumulate several successes and steps in the right direction that are worth highlighting.

3.1 Robust regulatory agency and institutions matter

Perhaps one of the most important assets, when dealing with a situation in which agents have competing interests and do not wish to part with legacy benefits they are (arguably) entitled to, is to have a robust mechanism of governance and trustworthy institutions to lead communications and discussions with society.

The current Brazilian regulatory framework originates from the 1988 Brazilian Federal Constitution, which highlights that public services are a responsibility of the state but can be granted to private companies – opening the way to privatizations in the 1990s. The Brazilian regulatory authority ANEEL was created in this context in 1996, as a technically, administratively, and financially autonomous institution.

Even though sporadically, there have been initiatives in Congress to challenge some of ANEEL's decisions, in more than 25 years of the Brazilian Power Sector Regulatory Framework, the net effect has been a strong regulatory governance driven by technical priorities rather than political ones. ANEEL is a regulatory agency that has gone through many cycles of (different) federal governments, maintaining its core characteristics, its respect for the sanctity of contracts, and has contributed over the years to the security, robustness, and trustworthiness of the sector. While the Ministry tends to be more politically minded and more subject to transient energy policies, having a more technically minded regulator strengthens the institutional framework. Brazil also has other autonomous institutions that may be involved in the matter of the evolving electricity market framework – such as the system operator ONS, the market operator CCEE, and a planning company EPE. In addition, there is a culture across Brazilian institutions of running public hearings with ample participation from interested parties and of sharing technical documents with analyses of potential impacts of various policy decisions. These efforts have contributed to ensuring that, most of the time, electricity market agents are well-informed and that their concerns are heard.

Despite the complexity of the matter of retail liberalization, a robust institutional framework like this one is virtually necessary to reach consensus or to make decisions on controversial topics, with the regulator playing the role of an independent arbiter when needed.

3.2 Regulatory "backpacks" to maintain a balanced costs allocation to final consumers

The need for a retail liberalization that does not cause tariff increases for consumers who remain in the regulated market is a concept explicitly provided for by Brazilian law. This concept constitutes an important framework for the regulatory design, although it has not always been observed, as shown in some of the examples mentioned previously.

In this sense, the notion of a regulatory "backpack" in the context of the electricity sector relates to a consumer, when migrating to the free market, taking with them a portion of the surcosts incurred by the Distco "on behalf of" this consumer, when it was part of the regulated market. The idea is that, even if the consumer is allowed to migrate, it must migrate taking its "backpack" with them. There are examples in which this core concept is applied in Brazil.

Brazil organized in 2020 a loan to cover Distcos' extraordinary expenses during the Covid-19 pandemic, to be repaid over the following years (the "Covid account"). Contrary to similar financial operations that had been carried out in 2014-2015, the Covid account mechanism anticipated that the costs of the loan would be paid by the regulated consumers *plus* any free consumers that ended up migrating after the loan was taken (ensuring they would still pay their fair share).

Another example refers to surcosts associated with legacy contracts in the Distcos' portfolio, an effort to avoid burdening only regulated consumers, as market liberalization expands. Bill 414/2021, currently under discussion in the Brazilian parliament, explicitly indicates that part of the excess contracting costs in Distcos' portfolios ought to be shared among all consumers (free and regulated), accounting for the fact that a large portion of this cost is due to consumers migrating to the free market. This same Bill also establishes that migrating consumers will have to bear the level of sector charges in the regulated market at the time of migration. Thus, the concept of a "regulatory backpack" is effectively introduced and reflected in Brazilian system charges.

With regards to sharing system reliability costs among all consumers, it is worth mentioning the country's reserve auctions for procuring peak capacity, with associated costs to be shared among all consumers (except self-producers) through a specific sector charge. Brazil's first auction with this purpose took place in 2021. Similarly, the country's third nuclear power plant, considered a strategic project, if constructed, will have its costs also borne by free and regulated consumers – contrary to previous nuclear power plants, that had been assigned to the regulated market exclusively.

Finally, it is worth mentioning that Bill 414 has provisions to reduce the risk that new and significant costs related to "incentivized sources" are transferred to regulated consumers. Indeed, the only hope of finding a healthy equilibrium between the free and regulated markets will be if costs are split fairly, especially in the case of projects that benefit the system as a whole.

3.3 Long-term PPAs: not only for the regulated market

Another success of the Brazilian market model has been the emergence of more robust financial instruments and the consolidation of free market consumers and retailers as reliable and creditworthy offtakers. Even though this might seem like an obvious development, given that the free market currently represents almost 35% of the country's consumption, it is important to remember that, when the Brazilian energy contract auctions model was originally conceptualized, it was generally agreed upon that no new generation capacity would be built unless they could rely on long-term contracts financially backed by a Distco. For several years, this indeed seemed to be the case – which is why most of the system expansion in the 2000s and 2010s was from projects that were committed in the energy auctions, and why the Distcos were saddled with a costly contract portfolio. Project developers were used to having access to these very long-term contracts with reliable offtakers and generous terms tailored to each technology.

Over time, however, free consumers started to show increasing appetite for procuring mid- to long-term contracts; and project developers have similarly shown a greater willingness to make investments in new capacity backed by free market contracts. Even financiers have joined in these innovations, accepting generators' demonstrations that, even if they do not have long-term contracts covering their entire operational period, they can follow a predictable contracting strategy that greatly reduces the volatility of their expected revenues (which, in turn, increases the maximum amount of financing they can procure). The success of these long-term contracting strategies is illustrated in Figure 5: around 40% of contracts have a duration of 4 years of more.

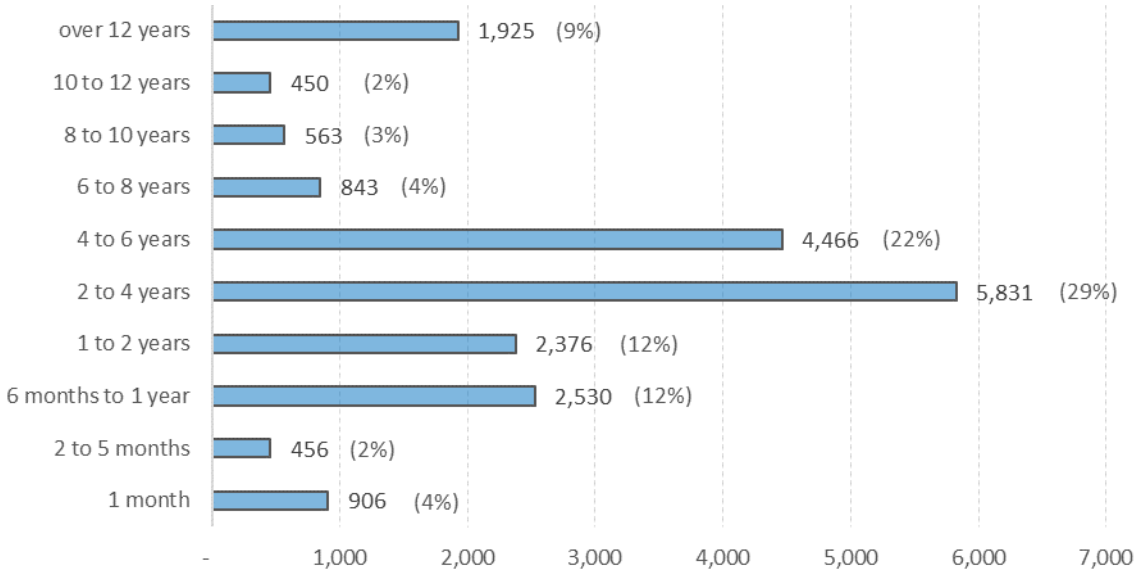

Figure 5- Total volume (in average MW) of contracts held by consumers in the free market in December 2021, classified according to the contract term. (Source: authors)

Current practices in the free market are not perfect, of course – after all, these long-term contracts are at least in part made viable by the legacy subsidies and regulatory arbitrages described earlier in this article. Furthermore, the expansion that is financed by the free market is almost fully based on the cheapest generation sources available, which have been wind and solar. This often launches a debate regarding to what extent these technologies – and hence free consumers – can contribute with necessary system services (such as flexibility and resilience) valued by the system operator and planner. Despite these limitations, a free market that plays a more active role and that is comfortable with financing new capacity is an important step for further improvements in the market design.

3.4 Modernization of the distribution business

Perhaps one of the most glaring deficiencies of the Brazilian market framework in its path towards retail liberalization is how the Distcos are structured, as a combination of distribution network owner and operator and a monopolist retailer for the regulated market. The most important recommendations raised in this context that directly affect the Distcos's business model and that could play a role in enabling market liberalization are as follows:

- Improve Distcos' tools (and incentives) to manage their contract portfolios, including facilitating the exchange of contracts among utilities and sales in the free market.
- Avoid new expensive and long-term contracts in the regulated market, focusing on more technology-neutral auctions, with shorter contracts offered to suppliers, and with the costs of valuable attributes shared between all consumers to avoid free-riding on reliability.
- Unbundling retail and grid activities of Distcos, with specific regulatory frameworks for each, including guidelines for a "Supplier of Last Resort" services.

Grid digitalization is also under discussion, as in Brazil it is still incipient compared to the country's potential. Smart meters, for example, are available to roughly 1 million consumers, a tiny fraction

of Brazil's almost 90 million. Many regulatory factors that explain this timid rollout are known and being addressed, such as reviewing Distcos' revenue structure and reducing under-remuneration risks for grid services. A clear unbundling of the grid and retail businesses allows an identification of the risks these businesses are subject to and an indication of which "other services" could be provided by each of these two businesses. Altogether they could not only enable a more efficient market design but also a stronger diffusion of new technologies and innovative services – with ample synergies between these efforts.

4 In summary

In a context of increasing decarbonization, digitalization, and decentralization (with dissemination of distributed energy resources), there has been increasing pressure for retail liberalization across the world. Looking into how middle-income countries such as Brazil have been facing these challenges can be relevant for other countries with similar pressures. In addition to empowering consumers on their energy management, retail liberalization in Brazil gained momentum in face of the growth of distributed generation, which "liberalizes" the market to consumers that are still regulated. Hence, the authors perceive retail liberalization as a one-way road.

Without arguing the benefits of retail liberalization, to discuss it after almost 25 years of liberalization at the wholesale level is not an easy task anywhere. Contractual and regulatory legacies might compromise the overall efficiency of the liberalization process, as distorting price signals might overburden certain consumers and create self-reinforcing feedback loops without a well-conceptualized retail liberalization plan. This type of negative influence has been exemplified with the situation in Brazil, but it is a common consequence of legacy cross-subsidies in markets with partial retail liberalization.

The creation of free-riding opportunities for migration due to factors other than competition itself is also a risk, as costs not paid by one class of consumers must be paid by others. Lower-income classes might not be attractive to retailers, effectively remaining in the regulated market – which may deepen social divisions and create further concerns. In Brazil and elsewhere, it is not always feasible for the Treasury to simply absorb the cost of cross-subsidies, requiring a more complex solution.

In-depth knowledge of individual country contexts is important in order to find specific solutions for the conundrums involved in promoting full retail liberalization – which is why the Brazilian context was used to illustrate the broader issue. For Brazil and other countries facing a similar context, however, strategies tend to be based on similar core fundamentals:

- Discussions with market agents, political actors, and society at large, hopefully backed by strong technically oriented institutions – as illustrated by the best practices that have been part of Brazilian institutions' core procedures from the beginning.
- An element of regulatory "backpack" charges for fairly splitting costs between the free and regulated markets – while these have not been systematically applied in Brazil, there is increasing awareness to their importance, and explicit implementation on a case-by-case basis (e.g. Brazil's Covid-related program for electricity consumers)
- Equitable contracting practices between the free and regulated markets, with any extra costs deemed necessary (such as "reliability-driven" contracting) made transparent and

split by both groups. This is one aspect in which Brazil best serves as a cautionary tale to the potentially dire consequences of allowing imbalances and distortions between the free and regulated markets to persist (and the difficulty of handling legacy costs).

- A robust regulatory framework for Distcos, including, but not limited to, unbundling their retail and grid activities, with better designed incentive-based regulated contracts and tariff structures. Brazil has only taken its first steps on this front, although the need for a more modern framework for the distribution business model has been proving increasingly crucial.

5 For Further Reading

- G. Cunha, L.A.Barroso, F. D. Munoz; B. Bezerra; H. Rudnick, *Zero-Marginal-Cost Electricity Market Designs: Lessons Learned from Hydro Systems in Latin America* IEEE Power and Energy Magazine (Volume: 19, Issue: 1, Jan.-Feb. 2021).
- R. Ferreira, P. H. Corredor, H. Rudnick, X. Salazar, L.A.N. Barroso. Centralized or distributed generation expansion in South America? The cases of Brazil and Colombia. IEEE Power and Energy Magazine (Volume: 17, Issue: 2, March-April 2019).
- F. Amorim, J. Vasconcelos, I. Abreu, P. Silva, V. Martins, 2012. Assessment of legacy generation contracts' costs in the future Portuguese electricity system. 9th International Conference on the European Energy Market.
- Ministry of Economy Study on Brazil full retail liberalization (2022) "*Cálculos relativos aos efeitos econômicos e financeiros advindos do processo de modernização do Setor Elétrico Brasileiro*" available (In Portuguese) in https://www.gov.br/economia/pt-br

6 Biographies

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