Electricity rate structure design in Latin America: Where do we stand? Where should we go?[#]

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Abstract

This paper reviews some critical issues for addressing the structure of electricity tariffs for ulterior purposes of policy research agenda. Starting from economic principles behind electricity tariff design, this paper asks what options ahead Latin America has in terms of improving electricity tariff design from a heterogeneous *status quo*, where trade-offs among cost recovery, cost reflectivity and affordability stand out. Options look like an avenue for improving cost recovery through better wholesale market design and regulation; move outside excess volumetric pricing and towards fixed and capacity charges; reduce excessive increasing block pricing; promote metering and regulatory flexibility for menu pricing with optional schemes and guaranteed bills; foster flexibility for new customer clustering and pricing to accommodate innovation in the energy transition; attend affordability with lump sum transfers through differentiated fixed charges and taxes and reform taxation to coordinate tariff format reform across different regulatory jurisdictions. Above all these dimensions, countries should coordinate on common information standards on the level and structure of electricity rates.

JEL classifications: L51, L94, L98, Q41, Q48

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Introduction

Electricity pricing is undergoing a fast transformation in line with the substantial structural changes embedded in the energy transition. Seen from a historical perspective that started in the post WWII period under different organizational forms (Hansen and Percebois, 2017), electricity pricing will be reformed to accommodate two fundamental shifts in the basic grammar of costs and prices. First, marginal prices will converge to very low values (if not zero, as perhaps exaggerated by Heal, 2021) even with more time and space dependency or volatility. Second, fixed charges will emerge as much more important due to the more significant role of network costs in a decentralized system that incorporates diverse distributed energy resources. Those significant variations in generation and locational cum congestion costs move the trend towards time of use pricing schemes that now face much less frictions or transaction costs, due to the astonishing impact of digitalization.

This gigantic shift puts a lot of pressure for reform of the *status quo* of electricity pricing, particularly in emerging economies like those of Latin America and the Caribbean (LAC), where the "pricing code" is still conceived in the old paradigm, extremely biased towards volumetric components without a correspondence with costs components, unrelated to time-varying differentiation and with an excess of discriminatory pricing embedded, in many countries, in an overuse of block pricing[1]. Annex A list official and commercial sources in 12 LAC countries where the format of tariff structures in electricity can be collected.

In addition, LAC is trapped in a regime where affordability is perhaps a prime impediment for an efficient rebalancing towards fixed charges, resembling the equity/efficiency debate on two-part tariffs (Feldstein, 1972; Brown and Sibley, 1986; see an application in Navajas and Porto, 1990 and more recently in Borenstein and Davis, 2010). The inefficient trap of current electricity pricing structures in LAC is well illustrated in recent papers by McRae and Wollak (2021) on Colombia, Hancevic, Nuñez and Rosellón (2022) on Mexico, and Urbiztondo, Barril and Navajas (2020) on Argentina. All three papers present tariff design pitfalls that need to be reverted to better accommodate the energy transition.

LAC countries do not have extremely high electricity prices on average compared to other regions. In addition, the levelized cost of electricity (LCOE) in LAC is relatively low, mainly due to the high presence of hydropower electricity generators (see Figure 9 in section 6 below). However, the average burden of electricity bills on households' total expenditure or income is very high (see Cavallo, Powell and Serebrisky, 2020 and Mejdalani *et al*, 2022). Beyond the drawback of high poverty and low household purchasing power, electricity prices cannot accommodate to affordability due to inefficiencies accumulated in public

[1] Evidence shows that this is not a completely uniform feature in the region, with, for example, Brazil, Chile and Colombia not displaying block pricing. However it is rather pervasive in many countries such as Argentina, Bolivia, Costa Rica, El Salvador, Mexico, Paraguay and Uruguay. This includes block pricing of volumetric components and in some cases (Argentina, Bolivia, El Salvador, Peru and Uruguay) of differentiated fixed charges. The Argentine case illustrated in section 5 is perhaps the most salient case.

enterprises, the regulatory system performance (due to high cost of capital and lack of regulatory credibility) and an excess burden of electricity taxation. Therefore, affordability problems create three problems for electricity rate performance in LAC: First, they affect tariff levels posing problems for cost recovery and cost reflectivity; second, they give rise to excess rebalancing against business; third, they lead to excess proliferation of inefficient discrimination across households (see Navajas 2006, for Argentina).

Against this backdrop and given *status quo* in LAC (which is quite heterogenous in terms of regulatory institutions, pricing practices and affordability problems), our main purpose is to contribute to the shaping of an information and policy research agenda in the region. We do so by discussing principles and guidelines of tariff design from a methodological angle; separating conceptually tariff elements between variable and fixed components; providing a discussion of the correspondence of tariffs with cost categories; isolating tariffs from other components of end-user price signals such as taxes and charges; discussing elements of consumer type classification; contributing to the agenda of reform of pricing and tariff design in electricity and the options of trade-offs open to tariff reform and suggesting components of a dataset and information requirements for such an agenda.

This paper is organized in the following sections. In section 2, we review some principles for rate (tariff) design with an eye on what we believe is LAC electricity tariff *status quo* bias towards electricity tariff design. In section 3, we deal with the definition and correspondence of tariff components and cost categories, a central topic for the study of the comparison of the structure of electricity tariffs. Section 4 addresses the definition of customer types for the comparison of tariff structures. Section 5 calls attention on a coordination problem between tariffs, charges and taxes across regulatory jurisdictions. Section 6 summarizes our view of trade-offs, alternative scenarios and options ahead for electricity tariff progress with an eye on relevant, and useful for policy guidance, comparisons of electricity tariffs in LAC. Section 7 concludes with some remarks.

Relationship with recent literature. We relate to the issues addressed in a recent unpublished draft by Mejdalani *et al* (2022), but with an emphasis on pricing principles received from the extensive literature on optimal utility pricing. Borenstein and Bushnell (2021) and several supporting papers are closely related to our approach to cost reflectivity in electricity. We also relate to the evidence and debate on non-linear tariffs and average versus marginal signals response by consumers (Borenstein, 2009; Ito 2014; Ito and Zhang, 2020; Shaffer, 2020; Lavandeira *et al*, 2022) for its implications to evaluate excess differentiation of tariff blocks (something found in Navajas and Porto, 1990 and Borenstein, 2010 from distributional or welfare perspectives). On cost structure issues, we relate to ACER (2021) approach on electricity distribution, which is also useful on customer type classification. We also discuss pricing implications of cost structure envisaged in Borenstein (2016), Perez-Arriaga *et al* (2017) and Helm (2017). Faruqui and Tang (2021) provide an account of practices and trends in electricity tariff design which also maps into customer classification issues. We are linked to papers on LAC (McRae and Wollak, 2020; Hancevic, Nuñez and

Rosellon, 2020 and Urbiztondo, Barril and Navajas, 2020) that have pointed out electricity tariff design problems that lead to excessive volumetric bias or tariff differentiation. We use preliminary results from Navajas and Olguin (2022) in terms of the informational efforts to evaluate tariff schedules across different jurisdictions. Evidence on carbon pricing metrics relevant for electricity tariff reform is taken from Ahumada, Espina-Mairal, Navajas and Rasteletti (2023).

2. Economic principles behind electricity rate design

Utility pricing theory evolved through time accommodating first principles to institutional, regulatory and technological changes. This time is not different: electricity pricing was at the forefront of these advances and it is once again leading the change of paradigm.

This current wave can be seen as the third one in the advances of utility pricing theory. First wave was post WWII with a *de facto* equivalence between optimal indirect and utility pricing principles due to vertically integrated public monopolies. Marginal cost pricing, Ramsey pricing, peak /off-peak tariffs, two-part tariffs[2] were all significant advances with many contributions in theory and practice (see Turvey and Anderson, 1977 for electricity pricing). The second wave was the adaptation to efficient or incentive regulation, where rate design follows a cost-of-service regulation approach (see Wollak, 2008) and previous advances on price structures are incorporated into this setting (Brown and Sibley, 1986) but perfecting (especially non-linear) pricing mechanisms and accounting for informational asymmetries (Laffont and Tirole, 1993; Wilson, 1993). Dynamic pricing (i.e. prices that are reflective to market conditions, like time-of-use (TOU) or real-time pricing (RTP) advances moved in through this second wave, although practice went behind (or, perhaps, followed another route from) theory, particularly in LAC.

The third wave is now ongoing and not yet completed, conceptually speaking. It stems from the energy transition process and the fundamental changes in the structure of costs, decentralization and use of information technologies (digitalization). It is driven by two fundamental shifts in the basic grammar of costs and prices: marginal prices will converge to very low values (if not zero, as exaggerated by Heal, 2021) and fixed charges will emerge as much more important, due to the technological shift towards renewable generation and to the much more significant role of network costs in a decentralized system (Perez Arriaga *et al*, 2017). Given this, and from an applied theory and policy perspective, there are two fronts to address, with implications on rate design. One is the design of wholesale electricity

[2] Glossary for non-economists: *Marginal cost pricing*: efficient opportunity cost pricing that reflects relevant incremental costs. *Ramsey Pricing*: when a multi price structure needs to address efficiency subject to some profit or regulatory (cost-of-service) constraint, price discrimination can proceed efficiently leading to price-(marginal) cost margins that (inversely) relates to the elasticity of demand, under some conditions. *Peak/Off-Peak*: Demand fluctuations lead to prices responding to demand conditions; *Two-Part tariffs*: when fixed costs need to be financed/covered and the instruments allow the use of a fixed charge, then, a two-part tariff can be efficient in not distorting through positive price-cost margins but instead use the fixed charge. Several illustrious names in economics in the 20th century (Harold Hotelling, 1938; Frank Ramsey, 1927; Ronald Coase, 1946 and Marcel Boiteaux, 1956, to mention only a few pioneers) are associated with the discovery of these pricing mechanisms.

markets (see Cramton, 2017). The other is the design of rate structures across users, types of use, time of use, space, etc.

In wholesale market design two options show up, with scholars divided on the weights. One is to remunerate for capacity and depart from the upcoming marginal cost pricing volatility. The other is to put more emphasis on more accurate and extreme scarcity pricing. Arguably perhaps, some scholars in the UK and Europe favor the first (Hansen and Percebois, 2017; Helm, 2017, 2021) while in the US there is more optimism to use marginal price signals to avoid distorting socially efficient pricing (Borenstein and Bushnell, 2021 might be here although with a balanced view). Views on the working of wholesale markets are not irrelevant for tariff design, despite the fact that passthrough or procured energy bought by utilities may conform to a market equilibrium price (with externality corrections through carbon pricing mechanism). The point is that the marginal price signal becomes more or less relevant under alternative views or pricing paradigms.

In so far as rate design, there is an emerging consensus on the basic ingredients or principles that should guide rate structures. First, marginal prices should be set close to social marginal costs (for example, incorporating CO_2 emission costs through carbon pricing on fuels used in generation) and reflect scarcity values through locational pricing and variations in demand conditions. Second, tariff schedules should not depend in excess on quantity consumed, i.e. should be rather uniform across volume of energy consumed. Third, fixed charges play an increasing role in financing fixed, common or policy costs, i.e. infrastructure services should not be charged to volumetric components. Fourth, taxes and other charges should not exacerbate the bias towards volumetric end-user pricing. Rather, they should collaborate on financing fixed costs and help compensating for equity impacts of reform.

The previous principles lead to two-part tariff design with taxation possibly more biased towards affecting fixed charges (accommodating subsidies there). A central aim is to escape from excess volumetric pricing with respect of what is desirable for socially efficient electricity pricing. There are, however, many problems to overcome. Some are conceptual (why is increasing block pricing not advisable? What are the limits to scarcity pricing?). Others pertain to how to overcome behavioral, social or political constraints. After all: Is it not "*ex post* optimal" what we see in practice? Theory and practice suggest it is not. We choose to focus on two challenges. The first is how to shrink or reduce suboptimal increasing block pricing and secondly, and more important, how to cover fixed costs and through what mechanisms. Both are central to the principles behind tariff design and we discuss them separately below.

2.1 Increasing block pricing

From a utility pricing perspective, one can see increasing block pricing as a tariff schedule chosen to follow certain objectives, such as providing a low-user facilitation or access, incorporating equity objectives or giving signals to promote energy or capacity savings. Utility rate design can be explained and taught in a sort of progressive fashion where one starts with a simple two-part tariff, introduce a third part as a social tariff or low-user scheme

(Phlips, 1983; Armstrong, Cowan and Vickers, 1990; see also Navajas 2013 for natural gas) and proceeds towards non-linear outlays for end users that can be shown to be Pareto-efficient (Willig, 1978), and are convex outlays, that is, led to decreasing rather than increasing blocks (Brown and Sibley, 1986). For increasing blocks, one needs to bring additional objectives of the sort mentioned above.

The problem with increasing blocks is in one way empirical. First, how many blocks to choose? (as evidence shows that in practice they do not match well with the distribution of users, see section 5 on Argentina). Second, continuous or discontinuous or uneven format and its implication. Third, the values of marginal and average values across blocks. However, the fact is that increasing blocks are not idoneous instruments for tariff design from applied theory but rather a preferred chosen instrument by regulators to pursue (or declare they are pursuing) distributive or "conservationist" (of energy) objectives. Evidence in electricity consumption patterns show that the correlation between consumption and income (i.e. Engel Curves) is affected by household characteristics so they make consumption across income or expenditure deciles much uniform than previously believed (Komives *et al,* 2005) and thus the "power" of these schemes to redistribute is low, a result that also applies to low user schemes (see Navajas, 2009).

Evidence from the US (Borenstein and Bushnell, 2021) confirms that blocks are either decreasing or increasing, but the size or magnitude (of price variation across blocks) is rather small. Other papers for the US have measured and criticized the distributional power of these schemes (Borenstein and Davis, 2010 and others). But for LAC we find mostly or exclusively increasing blocks and the size of price variation across blocks is not irrelevant. Navajas and Porto (1990) modeled a multi part optimal tariff for Argentina and found that the observed range of prices across blocks (10 to 1 or more) were unjustified from a distributional characteristics (of blocks) approach. More recently, Urbiztondo, Barril and Navajas *(*2020) found a range of fixed charges of electricity tariff in EDENOR Argentina that varied from more than 1 US dollar (monthly) to more than 50 dollars. This contrasts with the evidence in Borenstein and Bushnell (2021) that shows fixed charges in the US to distribute close to an average of about 10 dollars (with a wider range only emerging after a reform exercise that introduces social marginal costs).

Finally, conservationist objectives or scarcity (capacity) signals cannot be properly addressed by increasing blocks of tariff outlays with frequencies of metering and billing that do not correspond or reflect those costs across time. This is also related to the evidence and debate on the behavioral response to non-linear tariffs or to marginal vs. average price signals (Borenstein 2009; Ito 2014; Ito and Zhang, 2020; Lavandeira *et al*, 2022) and the problem of limited rationality or rate literacy (Redden and Hoch, 2006, Shaffer, 2020). Complex or ill-defined and discontinuous increasing block pricing is unlikely to obtain proper or desired (conservationist) household response, more if average prices matter most for consumers. This also affects, fair to say, the desired results obtained from two-part tariff reforms such as those we evaluate in section 5 below. Thus, the context in which reforms are designed and ex ante evaluated should take this literature more seriously.

2.2. Fixed charges and fixed cost recovery

The next critical issue related to the preferred principles mentioned before concerns the recovery of fixed costs. Principles here suggest that a fixed charge would do the job, and it may not be too large in those cases where pricing at social marginal costs that are high due to externalities (and therefore well above private costs) create a price cost margin from which to finance those fixed costs (see Borenstein and Bushnell, 2021). However, as remarked by Borenstein (2016) economic principles are less (or no) explicit on how to cover fixed costs. The early literature on optimal utility pricing pointed to a combination of fixed charges and price cost margins (where two instruments are going to be weakly dominant over just one, e.g. Tirole, 1988) or price cost margins were thought in terms of Ramsey pricing. Perez Arriaga *et al* (2017) and Borenstein and Bushnell (2021) discuss alternatives, including Ramsey pricing. The problem with Ramsey pricing is that is a so-called third-degree discriminatory device that requires categories of separated consumers. Within residential users (where the main issue stands), it is more difficult to find an observable and measurable variable. Quantity consumed or blocks (as shown in Navajas and Porto, 1990) do not qualify for reasons explained before and other household characteristics (as suggested in Perez Arriaga *et al*, 2017, such as property) lead to a discriminatory device that may be useful to consider but it looks difficult to implement in many LAC countries, where evidence shows that property taxes face serious informational constraints most likely to arise in electricity tariff differentiation. The discussion in Borenstein and Bushnell (2021) concerning different types of use of electricity (e.g., water heating, lighting, cooking, air conditioning, etc.) could come in the future, as smart metering improves, but it is difficult to imagine right now, particularly in LAC. This is an issue related to the topic of classification of customers in tariff design.

This promotes the idea that recovery of fixed, common and policy costs through fixed charges is a better way if it is also supported by taxes that move away from variable or volumetric dimensions and help compensate for equity impacts (Navajas, 2018; Cont and Navajas, 2019). The need for compensation for distributional equity impacts has been shown in more advanced exercises with novel databases that study the consequences of moving to time of use (TOU) or real time pricing (RTP) (Burger *et al*, 2020; Cahana et al, 2022). Nevertheless, the idea that fixed costs recovery can be "moved away" from pricing to taxation may not be efficient (given the cost of raising public funds) or, more important, may not be politically feasible. Rather, the evidence suggests the opposite, with social issues not well managed by public finances ending up impacting on electricity pricing. Affordability problems in LAC are the best example of this. We explore the policy-option implications of this at the end of the paper.

3. Definition and correspondence of tariff elements and cost categories

We have seen that solid economic principles are essential to guide the analytics and measurement of electricity tariff and provide a rich set of issues for policy guideline; LAC needs to move in this direction. However, national regulatory authorities or ministerial offices in charge of tariff information and analysis (see Table in Appendix A) are less oriented towards efficient (social) pricing design issues than academic economists and usually demand orientation on far practical issues of tariff definition and classification. Cost recovery through regulatory procedures and accounting rather than (social) cost reflectivity of tariff schemes are among those issues. Besides, the definition and information components of tariff elements across national environments reflect different, heterogeneous conceptual and informative (transparent) settings that require an effort to make uniform comparisons.

The search for an understanding and for a policy dialogue approach to electricity tariffs in LAC needs to proceed by measuring what we observe today in the region. The sole measurement of electricity tariffs poses a question on what we really observe and what information countries offer in terms of the methodology of tariff setting and reporting. While this calls for an effort to make homogeneous comparisons of tariff components (e.g. fixed vs variable charges), there is still the problem of what methodology is behind what we observe and what national authorities inform and do not inform. Thus, while a discussion on methodological issues to support a measurement project of electricity tariff in LAC is a useful contribution, there is a previous and obvious point. This is to recommend a coordination across countries of the information provided in each case and a minimum set of requisites in terms of what such information should reflect or report. This is similar to what the IMF requires for fiscal and monetary statistics.

Given this, the question remains, whither coordination? i.e., behind which minimum standards? The sole observation of electricity tariffs begs the question of how much revenue is raised by which component (see Figure 1 in section 5 below) and reflecting which costs. That is, revenue collected by each tariff component, and their correspondence with costs is a desirable informative target to seek, the latter being the hardest part to get information. However, we need to clarify issues regarding some principles, to complement the discussion of the previous section. We do so in the following subsections.

3.1. Cost reflectivity, in the narrow and broader sense

Cost recovery is a central element of electricity pricing[3], as it maps to both macro (fiscal) and micro (allocative, distributive) considerations. However, cost recovery can be done without cost reflectivity, i.e., a uniform lump sum tax or charge across users can do the job of cost recovery, but at the expense of efficiency. What cost reflectivity means depends on the

[3] See ACER (2019, p.14) on precise practical definitions for electricity distribution: "*Electricity tariff design, in general, aims at recovering the costs incurred by a monopolistic system operator while stimulating efficiency. Cost recovery is the core objective of tariffs. Efficiency mainly relates to cost-reflectivity and the economic signals sent to the network users for optimal use of the network.*" See also CEER (2020, p.12): "*DSOs should be able to recover efficiently incurred costs. As well as tariffs for use of the distribution system, DSOs may also recover costs through connection charges and regulated services.*" See also Wolak (2008, p.2) for a discussion of cost recovery constraints in the context of cost-of-service regulation: "*When the cost-of-service regulatory process operates it sets a price that allows the public utility an opportunity to recover its operating costs and the regulated rate of return on its capital stock through prudent operation*."

broader or narrow view that one can adopt, which includes whether we are talking about energy pricing, network services or both. Thus, a first good approximation is to recognize the basic grammar of electricity pricing as decomposed in energy prices, transmission and distribution tariffs, other charges and taxes. This is a separation that one should require for each country in LAC in order to arrive at useful comparable tariff structures.

One can adopt a narrow view when referring only to the cost reflectivity of distribution tariffs and claim for some uniform methodology across countries to define tariff elements, and the cost categories that they should reflect, in a transparent way such that it allows stakeholder involvement and control. ACER (2021) follows this approach and sets minimum standards for methodology and cost reflectivity of distribution tariffs. This is necessarily a narrow scope, since ACER is dealing with distribution tariffs. Distribution tariff elements must be related to costs for building/upgrading/maintaining/operating the distribution infrastructure (i.e. capex and opex) and include losses in distribution networks. Transmission (transport) tariffs have the same format and may include other system services and congestion charges. Other infrastructure charges, such as connection charges, are conceptually separated. As there are other policy charges, such as stimulus to foster renewables, energy efficiency programs, etc. Taxes, of course, should be separated.

However, one can see cost reflectivity as covering a broader correspondence between tariffs and costs categories, within a more general treatment of electricity price signals. When dealing with electricity pricing structures in LAC, we are dealing with end-user signals that necessarily should encompass all aspects of cost reflectivity, from energy prices to network services. Even charges and taxes have to be put in the picture as they form part of final prices and alter or change comparisons across countries. From this broader view, a set of basic or minimum elements for the definition of electricity tariff levels and structures is required.

- First, electricity pricing decomposition between energy, transmission, distribution is crucial for transparency and comparison.

- Second, fixed and variable costs are the basic difference in tariff design, but within this standard separation the “trilogy” of energy (volumetric), lump sum (fixed charges) and capacity components is crucial. Evidence from studies on the comparison of methodologies for electricity pricing structures tries to separate these three basic components; see Table 1 based on ACER (2021) for the EU.

Table 1

Percentage Allocation of Components of Electricity Charges

selected EU countries

Member State	Energy (%)	Power (%)	Lump-sum (%)	Year
Belgium (Brussels)	82	0	18	2020
Belgium (Flanders)	85-90	10 15	<1	2020
Belgium (Wallonia)	95	0	5	2020
Bulgaria	75	25	0	2019
Croatia	84.8	15.2	0	2019
Cyprus	100	0	0	2020
Czech Republic	51	49	0	2018
Denmark	95	0	5	2019
Estonia	81	NA	NA	2018
France	70	16	14	2019
Greece	82	18	0	2020
Hungary	77	20	3	2019
Ireland	68	9	23	2019/20
Italy	0	95	5	2020
Latvia	68	32	0	2020
Lithuania	100	0	0	2020
Luxembourg	59	16	25	2020

Source: ACER (2021), see footnotes 90 to 96 in page 43 for definitions specific to some countr

- Third, the correspondence of these elements with costs is also essential, in the sense of knowing which costs are being covered or reflected by which tariff component. Table 2 below taken from CEER (2020) methodological comparisons of distribution tariffs in the EU shows a standard format for tariff/cost correspondence.

Table 2

Correspondence between tariff elements and cost categories

Table: DSO costs

	Present cost			Future cost
Cost categories	**Short-run marginal costs**	**Customer specific costs**	**Residual (sunk) costs**	**Long-run marginal costs**
Description	Network losses and variable payment related to DSR	Metering and data processing	Other costs for coverage according to the regulation	Cost for increasing capacity (wire and non-wire option)
Preferred tariff design	Marginal pricing (Energy Time of Use)	Cost-based (Fixed)	Cost-based (capacity, Fixed)	Semi-marginal pricing (Energy Time of Use, capacity peak pricing)

Source: CEER (2020)

- Fourth, the across time and space variation of (or their absence from) tariff elements is nowadays crucial, given the trend in electricity pricing across the world, as documented in Faruqui and Tang (2021).
- Fifth, distribution tariffs should distinguish their reflection of cost categories, that belong to use and maintenance and losses, from other system services related to the network.
- Sixth, current taxes on bill components and charges to infrastructure funding should be measured separately.
- Seventh, energy subsidies and their interaction with electricity tariffs should be recognized.
- Finally, social marginal costs of energy, in particular the introduction of carbon pricing, and the relationship with substitutes (e.g., natural gas, LPG, biomass, liquid fuels) must be accounted for, as shown in Borenstein and Bushnell (2021).

3.2. Cost structure and regulatory accounting

The proper measurement of fixed and common costs including policy obligations is a critical issue and one that I found less documented in the literature on rate design, that assumes some separation between fixed and variable costs can be performed. Errors in the correct separation of fixed and variable costs have implications for efficient pricing (and equity as well) whether they are Ramsey prices (Urbiztondo, 1997) or any non-linear tariff scheme. Informational asymmetries and strategic behavior by utility firms make this issue also critical. Studies of the share of fixed costs on total costs or revenues may be useful, although subject to structural differences across countries.

Improving regulatory accounting divisions inside regulatory bodies is one way to improve measurement and therefore pricing. However, advances here and, in particular, its allocation may also depend on metering technology issues. It will require advanced smart metering, since imposing load-demand pricing without metering will be arbitrary and inefficient (see Borenstein, 2016). LAC is here in a rather weak position (see Weiss, Hallak *et al*, 2022). One way of introducing load-demand pricing with smart metering into fixed charges that also reflect willingness to pay for network infrastructure is proposed by Wolak (2018) (see also Cont and Navajas, 2019 for a discussion). However, a few guidelines can be pointed out. Some come from the general search for a change in the "doctrine" of service costs (Helm, 2017; 2021), which is of course debatable, and also includes generation costs. Among them is the vision –correct in principle– of decoupling the cost of service from the stranded costs of erroneous decisions or the costs of policies or technology subsidies.

3.3. Tariff structures and security of supply

Since the recent European energy crisis created by the invasion followed by the Russia-Ukraine conflict, the security of supply dimension has been brought to many policy areas including tariff policy design. Indeed, ACER (2021) recognizes two levels regarding the signals and incentives that the distribution rate design must address. One refers to the incentives for operators (TSOs, DSOs) to properly operate the infrastructure, the other for users to capture adequate price signals. Both, but the first to a great extent, belong to the design of regulation by incentives (to the operators). They are two different levels of price signals and ACER (2021) mentions the issue of energy security (along with grid integration, loss management, etc.) as belonging to the first group.

Clearly, systemic elements such as those related to security of supply (and adequate investment and operation for it) are better captured by the operators' incentives. However, there are links to the design of price signals aimed at managing demand and security of supply that can also be included. Security of supply corresponds to systemic costs that can only be partially reflected in pricing schemes and it is desirable they do not interfere with efficient pricing, or form part of a comparable blueprint of tariff structures, as countries may address the issue in quite different forms. Security of supply is different when related to commodity (i.e., energy inputs or final electricity output) or network elements of supply. Recent concerns are more related to the former. In any case, and particularly in the case of electricity networks, systemic elements related to security of supply act as a quasi-public good and therefore are less related to tariff structure design. Except for the demand management interrelationship, which maps into time of use or space constraints elements of tariff structures.

4. Consumer types definition and the comparison of tariff structures.

Comparisons or analysis of tariff structures in electricity use information based on actual tariff categories that segment demand according to load characteristics in separate customer standard types, leading to a somewhat sectoral classification (e.g., residential, commercial industrial). This is obvious if one wants to compare what prices or tariff a typical household or firm is paying across countries; i.e. some standardization is required. This classification is mainly organized according to load pattern or capacity demand, but many other features of “differentiation” include other dimensions such as space, time, sectoral or social characteristics. This will tend to differ across countries; thus, a minimum standardization for comparisons is required across LAC countries, i.e., what the targeted user groups are and which tariffs are offered. At the current level of (relatively low) sophistication in customer classification in LAC, the standard residential/commercial/industrial separation seems the reasonable norm to adopt, leaving new dimensions as a separate or lateral information to collect from now on. Evidence from other most advanced (than LAC) environments such as the EU (ACER, 2021) suggests that customer categories for the injection and withdrawal of electricity to and from the network, which includes prosumers and new network user groups such as EV.

Related with this simple approach to standardization-for-comparison is the definition and grouping of customer types for an efficient and evolving pricing of electricity. This is like a movie or path while the previous was a picture, with new types of customers classes showing up, albeit in a relatively slow motion in LAC. Best practices, on the one hand, and LAC countries, on the other, are located in different points or stages of this process. Thus, within an analysis of best practices in electricity tariff design (such as for example the one presented by Faruqui and Tang, 2021; based on a global survey of utilities) customer grouping comes as an element related to the objective of making tariff design more efficient in the sense of better reflecting costs and signals, saving capacity use, managing bill volatility, etc. They comment on 12 cases from Africa, Asia, Australia and NZ, Europe and South America (Brazil and Chile) that they include in the group of international best practices and 11 cases from the US and Canada. There are several programs in optional and mandatory formats across countries. Their emerging picture of what lies ahead is TOU cum demand/capacity charges with DER integration and including flexible optional pricing in various forms. Given the still incipient nature of these developments, need of pilot cost-benefit analysis of net gains is required, along with opt-in/opt-out clauses, transparency and estimates of gains for customers, bill guarantees, etc. When one looks for some classification or grouping of customers, the picture points to capacity or load and time of use as driving elements, along with the treatment of prosumers. Of course, this depends on metering improvement and demand response, a promising issue that needs careful factoring in LAC (Weiss, Hallack *et al*, 2022).

A clear emerging feature of tariff design in practice, as the one surveyed by Faruqui and Tang (2021), is the increasing flexibility of pricing schemes, which also involve some participation of utilities in their design. This is important for the issue of definition of customers because it shows, in fact, that there is a delegation or auto selection component, akin to second degree or menu pricing differentiation. The standard categorization of customers to implement electricity tariff schemes assumes or takes those groups as pre-determined. As arbitrage is commonly excluded, the separation allows different prices that correspond to different demand and cost features, e.g., imagine Ramsey pricing which is third-degree price differentiation *par excellence*. In this setting, the choice or number of customer groups is normally not modelled, imagined as a costly activity. The setting of delegation and menu pricing is a different thing. Customers might be initially separated into some defined groups, but as we do not observe the precise "type" (e.g., load pattern or characteristics), a menu is offered and customers (auto) select themselves. Thus, while customer categories are (centrally) designed for this purpose, there is a decentralized choice of tariff categories. Wilson (1993) is the best theoretical reference on these issues.

ACER (2021) report on distribution tariff methodologies in Europe, while summarizing tariff setting principles, points to the need for a right balance between volumetric, capacity and lump-sum elements of tariff design elements "<u>directed at targeted user groups</u>" in order to send appropriate signals. It is, as if, targeted user groups are defined in terms of their different cost of service and provision. There is, however, less refinements on the actual grouping or targeting process. Table 3 (taken from Chapter 8), on groups of network users subject to distribution tariffs, draws more on the use of charges to include users who are both withdrawing and injecting energy. Grouping is, in general, "households" and "non-households" consumers; auxiliary services of generators; power-to-gas and power-to-X facilities; pumped hydroelectric energy storage facilities (PHES); other storage facilities (e.g., batteries); other network users, who both inject and withdraw.

Table 3

Distribution-connected network users subject to withdrawal charges

Table 15 Distribution-connected network users subject to withdrawal charges.

Member State	Household	Non-household consumers	Auxiliary services of generators	Users who are both injecting and withdrawing		
				Pumped hydroelectric storage	Other storage facilities (e.g. batteries)	Other network users (see table below)
Austria	Yes	Yes	Yes	Yes	N/A	Yes
Belgium (Brussels)	Yes	Yes	No	No	No	Yes
Belgium (Flanders)	Yes	Yes	Yes	N/A	Yes	Yes
Belgium (Wallonia)	Yes	Yes	No	N/A	Yes	Yes
Bulgaria	Yes	Yes	No	No	No	Yes
Croatia	Yes	Yes	Yes	No	No	Yes
Cyprus	Yes	Yes	No	N/A	N/A	Yes
Czech Republic	Yes	Yes	No	N/A	N/A	Yes
Denmark	Yes	Yes	No	N/A	N/A	Yes
Estonia	Yes	Yes	Yes	N/A	N/A	Yes
Finland	Yes	Yes	Yes	No	No	Yes
France	Yes	Yes	Yes	Yes	Yes	Yes
Germany	Yes	Yes	Yes	Yes[107]	Yes[108]	Yes
Greece	Yes	Yes	Yes	N/A	N/A	Yes
Hungary	Yes	Yes	No	N/A	Yes	Yes
Ireland	Yes	Yes	Yes	N/A	Yes	Yes
Italy	Yes	Yes	No	No	No	Yes
Latvia	Yes	Yes	Yes	N/A	N/A	Yes
Lithuania	Yes	Yes	Yes	N/A	N/A	Yes
Luxembourg	Yes	Yes	No	N/A	Yes	Yes
The Netherlands	Yes	Yes	Yes	N/A	N/A	Yes
Malta	Yes	Yes	N/A	N/A	N/A	Yes
Poland	Yes	Yes	No	No	No	Yes
Portugal	Yes	Yes	Yes	No	N/A	Yes
Romania	Yes	Yes	Yes	Yes	Yes	Yes
Slovak Republic	Yes	Yes	Yes	Yes	N/A	Yes
Slovenia	Yes	Yes	Yes	N/A	No	Yes
Spain	Yes	Yes	Yes	No	No	Yes
Sweden	Yes	Yes	Yes	Yes	Yes	Yes
Total	27MS: Yes	27MS: Yes	17MS+1R: Yes, 8MS+2R: No, 1MS: N/A	6MS: Yes, 7MS+1R: No, 13MS+2R: N/A	7MS+2R: Yes, 7MS+1R: No, 11MS: N/A	27 MS: Yes

Source: ACER (2021)

4.1 Load pattern, metering and clustering techniques

Given that load pattern is an essential characteristic for the grouping of customers and given that it relies on the capability of metering technologies, it is natural to establish a connection between smart metering and customer grouping for the purpose of designing and implementing an efficient tariff menu (based on the "trinity" of volumetric, capacity and lump sum). By the same token, definition of consumer types cannot advance beyond historical practice without metering. Cost Benefit of smart metering is an issue in LAC (Weiss, Hallack *et al*, 2022) and elsewhere, with sought benefits directed at either system management of grid reliability (more the US case) and at looking for customer-related capabilities (more the EU case). Utilities are most interested in the second objective as they aim at segregating a huge number of customers into certain classes based on daily load patterns.

However, daily load patterns of a given customer might change significantly from one day to another. To cope with this problem of classification and grouping, data mining techniques to analyze load data have a potential to improve classification. Here is where clustering comes in, which is a data mining technique for segmentation of a data set by assigning its objects to a set of clusters. Rajabi *et al* (2019) evaluate different clustering techniques for electrical load pattern segmentation. Techniques try to cope with the challenge (to clustering) of variable load patterns. Applications of these techniques look far ahead in the possibilities of guiding customer definition in LAC, far less to help to look at customer classification for the purpose of intercountry comparisons. However, simple applications might help in pilot studies that serve for the purpose of choosing customer groupings.

Other approaches that are less quantitative-based or more holistic in nature and based on surveys or case studies may contribute to customer definition or classification without the need to rely on advanced metering infrastructure or a cyber-physical distribution system. Barjak *et al* (2022) discuss this approach to customer segmentation in electricity. They adopt a socio-technological approach to customer classification, with many dimensions. Similar articles in this line are, for example, Hampton and Foley (2022). All in all, I find this literature not very useful from a purely regulatory design view on the standard and upcoming classification of customers that contributes to cross-country comparisons.

5. Coordination between tariffs and taxes

Electricity pricing involves end-user price signals where many interferences have to be taken into account. Taxes are a prime candidate to look at. From a theoretical point of view, pricing and taxation was a unified problem in the realm of optimal public pricing theory, because tariff design proceeded or assumed an organizational format (public provision) with an equivalence between public prices and taxes (e.g., Diamond and Mirrless, 1971). Both were conceived under the same guiding principles. However, the issue of coordination emerges as regulation and taxation become separated. Applying the old equivalent principles in a non-coordinated fashion leads to inefficiencies in both levels and structures of taxes, akin to the double marginalization problem (Tirole, 1988; as argued in Navajas, 2022). This issue is normally not attended because it is assumed that taxes (and charges) are relatively small, non-discriminatory or economy-wide (e.g., VAT) and do not interfere with efficient end-user pricing. However, evidence in LAC may suggests otherwise in many cases, as reported in Navajas (2017).

Apart from the coordination problem between pricing and taxation, there is an additional coordination issue across jurisdictions, even within a fully interconnected electricity system. They may have different regulatory constitutions (including public enterprises) and of course independence concerning provincial and municipal taxes. Inefficiencies may arise because pricing departs from social marginal costs across jurisdictions (Borenstein and

Bushnell, 2021) or because subnational taxes interfere with efficient signals. Navajas and Olguin (2022) address the issue of pricing and tax heterogeneity across distribution jurisdictions in a wholly interconnected electricity system like Argentina[4]. They also provide some useful insights on the database required to address electricity rate design issues in LAC.

They study the residential tariff structure of ten distribution areas of Argentina which account for more than 75% of the electricity consumed by households, for 2018, based on the Association of Electric Utilities (ADEERA) database. Table 4 reports some characteristics of the electricity pricing structures they cover, with a pervasive use of block pricing, in both fixed and variable components. In general, there is an excessive number of blocks regarding the rather concentrated number of customers in the first two blocks (from 66% to 75% of customers across jurisdictions).

Table 4

Argentina: Residential electricity rate structures across jurisdictions

		Argentina: Utility Rate Residential Structure 2018 in US dollars										
		Fixed Charge					Variable Charge					
	Utility/Province	Uniform	No uniform				Uniform			No uniforme		
			N° blocks	Min	Max	Ratio Max/Min		N° blocks	Free block*	Min	Max	Ratio Max/Min
1	EDENOR (CABA)		9	1.07	50.43	47.26		9	No	0.068	0.087	1.28
2	EDESUR (GBA)		9	1.14	50.16	43.95		9	No	0.068	0.095	1.40
3	EPE (Santa Fé)	1.69	1					4	No	0.090	0.177	1.96
4	EPEC (Córdoba)		4	1.29	2.61	2.02		4	No	0.100	0.188	1.89
5	EDEMSA (Mendoza)		3	0.34	4.31	12.64		3	No	0.104	0.117	1.12
6	ENERSA (Entre Ríos)	1.90	1					4	No	0.093	0.169	1.82
7	EDET (Tucumán)		5	1.04	4.28	4.13		5	No	0.077	0.102	1.33
8	EMSA (Misiones)		7	0.54	1.41	2.60		7	No	0.074	0.110	1.48
9	EPEN (Neuquén)		7	1.60	22.53	14.09		7	No	0.122	0.095	0.78
10	EJESA (Jujuy)	2.49	1					2	No	0.090	0.112	1.24

Source: Navajas and Olguin (2022), own calculation based on ADEERA

Values above are computed in US dollar terms because it is more useful for comparison with other countries. The year 2018 is a proper benchmark because it is a relatively stable recent year, where electricity subsidies where at the lowest levels in years (FIEL, 2020) and debts or arrears between distribution companies were also relatively low (compared to nowadays). But also, because is the year of the last National Household Expenditure Survey (ENGHo) which allow us to estimate the distribution of electricity consumption across households, corresponding to the 10 distribution areas.

Tax structures at the provincial and municipal levels are presented in Tables 5 and 6 showing some variety of forms (*ad valorem*, specific) and uniform/non uniform formats. In some cases, they compound the block increasing nature of pricing as well contribute to the non-continuous format of tariff schemes. Table 4 shows that, except in three out of ten utilities, blocks for fixed charges oscillate between 3 and 9, with ratios between maximum and

[4] For a recent account of the history and performance of public utility prices in Argentina see Cont, Navajas, Porto and Pizzi (2021).

minimum charges that go from 2 to 47. Blocks for variable charges go from 3 to 9 with a milder escalation than can reach a ratio of 1.96 (i.e. customers in the higher block pay 96% more per unit). So far as subnational taxes (tables 5 and 6), they differ between provincial and municipal levels. At the provincial level, they are absent in two cases, mostly *ad valorem* and uniform for the rest, with taxes that go from 0.6% (of the bill) to 12.6%. At the municipal level, they have again mostly *ad valorem* components that have a uniform format, oscillating between 4.5% and 24.7%, with 4 out of 10 utilities facing a specific format with increasing blocks.

Table 5

Argentina: Provincial taxes on electricity

		Argentina: Provincial Taxes					
		No Taxes	Ad-Valorem				Specific
	Utility/Province		Uniforme	Non uniform			Uniform
				Min	Max	Diferencia	
1	EDENOR (CABA)	**X**					
2	EDESUR (GBA)		0.64%				
3	EPE (Santa Fé)		1.50%				0.10 $/month
4	EPEC (Córdoba)			0.50%	2.00%	4.00	
5	EDEMSA (Mendoza)		12.59%				
6	ENERSA (Entre Ríos)			0.00%	11.00%		
7	EDET (Tucumán)		1.50%				
8	EMSA (Misiones)		1.50%				
9	EPEN (Neuquén)	**X**					
10	EJESA (Jujuy)		1.50%				

Source: Navajas and Olguin (2022), own calculation based on ADEERA

Table 6

Argentina: Municipal taxes on electricity

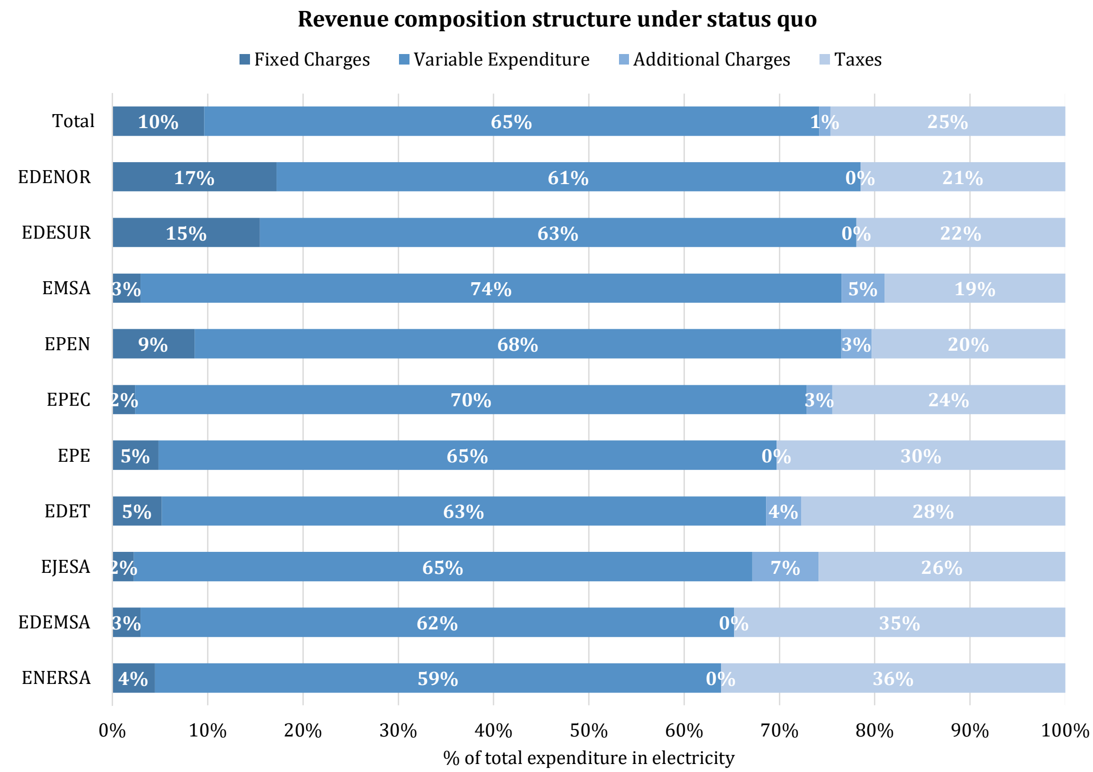
		Argentina: Municipal Taxes				
		No Tax	Ad-Valorem			
	Utility/Province		Uniform	No uniform $/month		
				Min	Max	Ratio Max/Min
1	EDENOR (CABA)		6.38%			
2	EDESUR (GBA)		6.42%			
3	EPE (Santa Fé)		8.40%	1.49	24.68	16.56
4	EPEC (Córdoba)		10.00%			
5	EDEMSA (Mendoza)			3.15	5.37	1.70
6	ENERSA (Entre Ríos)		24.70%			
7	EDET (Tucumán)		15.00%			
8	EMSA (Misiones)			0.10	0.23	2.29
9	EPEN (Neuquén)		4.50%			
10	EJESA (Jujuy)		6.00%	4.64	7.56	1.63

Source: Navajas and Olguin (2022), own calculation based on ADEERA

Microdata from the Expenditure Surveys for each area allow to allocate consumed quantities with tariff structure across deciles of income distribution for each area. The "*status-quo*" or observed revenue structure generated by the electricity tariff and tax structures of Tables 4, 5 and 6 can be computed using the data. This is illustrated in Figure 1 below with several interesting features. First, for the whole country sample, fixed charges cover 10% of total household spending, while taxes add up to 25% and variable charges represent 65%; other charges are relatively small and cover only 1%. Thus, if we exclude taxes (to get shares comparable to Table 1, for the EU) volumetric charges before taxes represent 85% of the tariff structure with lump sum (fixed charge) elements the rest and no share for capacity charges.

Figure 1

Argentina: Revenue composition structure of electricity tariffs across Jurisdictions



Source: Navajas and Olguin (2022)

However, the distribution across jurisdictions of this revenue structure changes significantly, particularly between the two big distribution companies (EDENOR, EDESUR) covering the Buenos Aires Metropolitan Area (AMBA), which have a block increasing scheme of fixed charges (see Table 4), and the rest of the country. As we move inside the country, there is a smaller participation of fixed charges and a larger share of taxes, with differences, of course, explained by different provincial and municipal taxes. Subnational jurisdictions tend to underprice fixed tariff components and significantly increase the tax burden on electricity consumption. Also, with smaller distribution and density areas they end up with (distribution costs and) tariffs significantly higher than in the AMBA. Taxes, therefore, pyramid on higher tariffs values, representing a significant source of revenue for subnational jurisdictions. This creates a *status quo* quite complicated for a reform, given the constitutional right of jurisdictions to set taxes. Thus, any reform towards a more uniform format of tariff design requires a political coordination similar to what has occurred in other instances with, for example, sales taxes or royalties on natural resources.

Navajas and Olguin (2022) simulate 3 reforms (in an incremental fashion) out of this *status quo* and compute the impact across households. They are basically a reform of the tariff structure format, an increase in the share of fixed charges and a ceiling on the share of taxes. They must account for revenue neutrality for utilities and also for subnational jurisdiction; in the latter case involving a distribution share mechanism. Also, lump sum transfers across households are required. [5]

6. Tradeoffs and options ahead

Methodological principles and best practices point to a direction of reform for electricity utility pricing in the case of technologically mature networks with well-developed regulatory institutions, low cost of capital and fiscal space and many instruments at hand, all shaping the route towards an energy transition. Electricity pricing structures are i) based on volumetric, capacity and lump sum instruments; ii) directed at giving right signals to reflect (private and social) social marginal costs, time of use, scarcity and network congestion; iii) with a better correspondence with short and long run costs; iv) in networks with an increasing share of fixed and common costs, v) with a better definition of customers for the withdrawal from and injection to the network; vi) with increasing flexible, delegated menu pricing schemes; vii) accommodating affordability constrains of households.

Evidence partially surveyed by different reports show that LAC is located in a different *status quo*, with some visible institutional, technological, distributive and fiscal constraints that make some parts of the above-mentioned direction of reform more achievable than others. Thus, LAC has a transition policy choice problem because the structure, the starting point and the policy inertia elements are different across countries. Still, there is a line of reform with some common features across countries that recognizes some central dilemmas in LAC.

[5] In reform A, they simulate a revenue neutral (for utilities) change in the tariff structure towards a two-part tariff format. For each jurisdiction, they make all (initially heterogeneous across households) fixed charges, marginal prices, charges and taxes become uniform to conform a similar two-part format with total revenues kept constant and respecting the share of fixed and variable component revenues. Thus, the exercise only modifies the *status quo* insofar as the tariff format is concerned. It does not adjust for social marginal costs (as in the exercise performed in Borenstein and Bushnell, 2021) neither does it perform a rebalancing between fixed and variable components (as in Urbiztondo, Barril and Navajas, 2020) nor adjusts for electricity subsidies. In a second reform exercise (Reform B), they make the same simulation as in Reform A (i.e., revenue neutral change), but produce a rebalancing of fixed and variable components of the *status quo*, by making all fixed charges to account for 20% of revenues for utilities. Both reform A and reform B, as they leave revenues constant, do not imply a (significant) change in tax revenues (as taxes are mostly *ad valorem*), i.e., both reforms are also neutral in fiscal revenue terms. In the third reform exercise, Reform C, they start from Reform B and assume that tax revenues cannot represent more than 25% of end-user expenditures, which in our sample is the average across jurisdictions. This reform is equivalent to a tax coordination across jurisdictions. As the federal VAT (and also part of a revenue sharing across provinces) at 21% is equivalent to about 17.4% of end-user expenditures (0.21/1.21), this leaves subnational governments (provinces and municipalities) with margin for choosing taxes up to 7.6% of end-user expenditures or equivalently taxes no larger than 15.6%. This is a very generous margin for some jurisdictions and implies a reduction of subnational taxes for others.

The following subsections start by suggesting a simplifying trilemma among affordability, cost reflectivity and cost recovery and then move to suggest options or zone of action for rate design improvement. We also take the opportunity here to bring to the discussion of electricity rate design the impact of current energy price shocks and the likely impact of carbon pricing.

6.1. LAC electricity pricing tradeoffs

As recognized in Cavallo, Powell and Serebrisky (2020) electricity end-user tariffs in LAC are not too expensive compared to developed countries, but they are quite unaffordable in terms of the share of electricity spending in household incomes. Given the low cost/rich resource base of electricity generation in many LAC countries, due for example to hydrological or hydrocarbon resources, one possible reaction to this performance is to blame the relatively disadvantaged position of LAC in terms of regulatory institutions and cost of capital. This is indeed an important element in LAC configuration. At the tariff design level, however, there are three vertices of a trilemma that are complementary to that view but also more specific in relation to the reform elements mentioned before. Table 7 below depict the trilemma and describe the associated tradeoffs.

Table 7

Electricity tariff tradeoffs

	Affordability	Cost Reflectivity	Cost Recovery
Affordability			
Cost Reflectivity	Regressive pricing; distortive cross subsidies		
Cost Recovery	Onerous sunk costs; low ability to pay	Inefficient costs; insufficient prices	

First, affordability is at the center of the tariff design problem in LAC and should be treated not as a secondary constraint to be solved from the outside but rather be assumed as an entrenched element in tariff design. Secondly, cost recovery is another distinguished and idiosyncratic feature in LAC because the level of tariffs does not usually cover costs, beyond the pricing structure adopted. This maps into fiscal performance, as LAC has a significant level of fiscal energy subsidies as reported in IDB studies (Pessino, Izquierdo and Vulletin, 2018; FIEL, 2017, 2020) quite different and more biased towards electricity subsidies than for example the EU.[6] Thus, cost recovery is central in LAC above any fruitful discussion on electricity tariff structure, as the evidence of electricity tariffs in Argentina shown before made clear: electricity tariffs in 2018 (a relatively favorable year for comparison) covered less than 70% of energy costs. Thirdly, we include cost reflectivity in the broader sense discussed above in section 3 and representing both the correspondence with cost categories and also the design of the tariff structure to reflect socially efficient marginal cost. Tradeoffs between affordability, cost recovery and cost reflectivity come when some tariff design proceeds by attending one at the expense of the other. Cost recovery, if based on inefficient or cost ineffective energy and network costs, will both impair affordability and will not reflect correct price signals. Affordability may come at the expense of cost recovery and the tax payer or be based on distortive price structures that emerge by default. Cost reflectivity may be regressive and collide with affordability.

6.2. Options or zone of action

An adaptation of the list of elements of reform at the beginning of this section adapted to LAC should take into account the previous trilemma (where affordability and cost recovery play a greater role than in mature networks) and what we may term the scope or "zone of action" for LAC in the "ladder" of tariff design innovation the world is witnessing, according to the database compiled and shown by Faruqui and Tang (2021) and described before in section 4. Figure 2 shows the steps in terms of tariff design innovations and reflects both technological (i.e., metering) and affordability constraints, which bias required solutions towards low users of electricity.

Figure 2 presents an ordering that seeks to represent a classic return/risk frontier where return means bill savings in terms of electricity spending (of energy and power) and risk is represented by bill volatility.[7] LAC has an immediate zone of action which is to improve the standard tariff benchmark and move into capacity pricing and time of use (TOU) while at the same time improves mechanisms for low users. A movement towards capacity pricing and TOU will improve cost reflectivity, while low user schemes will better attend affordability.

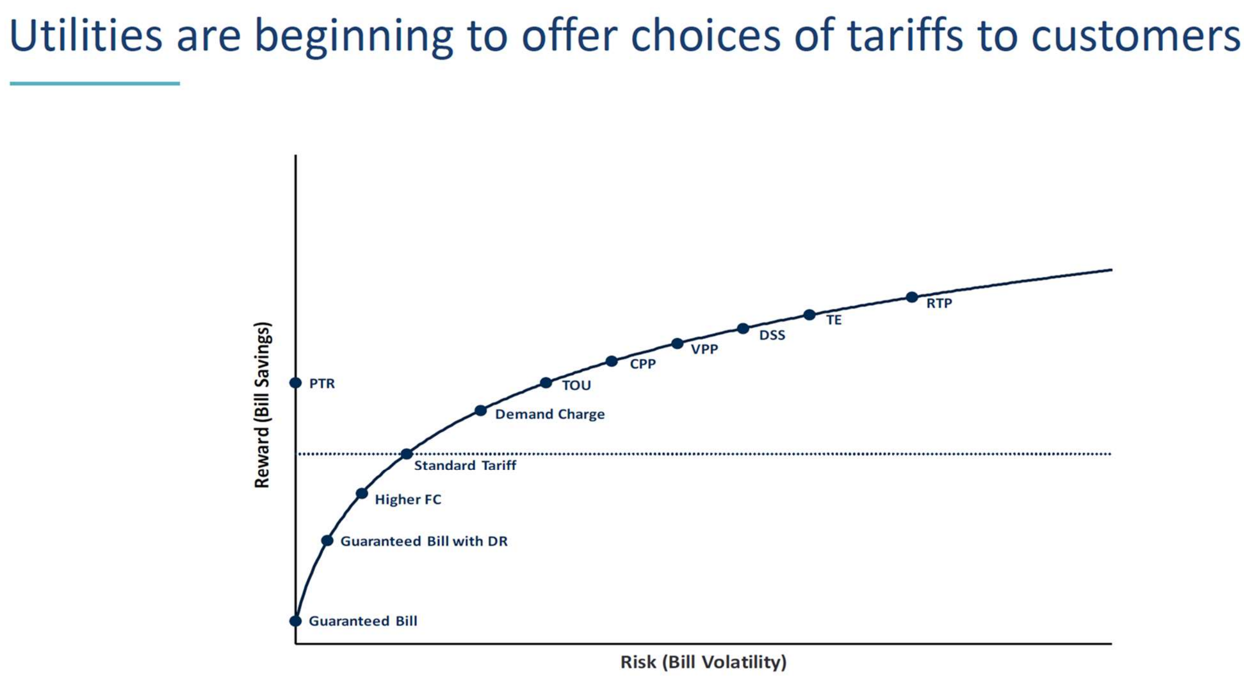
[6] European Commission (2021) accounts for the level and structure of fiscal energy subsidies (i.e. those registered in budgetary operations) in the EU-27 showing an average of about 1.2% of GDP with large cross-country differences, mostly directed to renewable energy schemes and with fossil fuels accounting on average for about 0.3% of GDP and located in transport, manufacturing and agriculture. Electricity subsidies are a minor part of energy subsidies and subsidies to households explain less than 10% of aggregate subsidies, with this figure changing dramatically in 2022. On the contrary, electricity explains about two thirds of energy subsidies in LAC (on average 0.6% of GDP in a similar budgetary definition), according to FIEL (2020) and households have also a share of 66%.

[7] TOU (time of use) refers to the day divided into peak and off-peak periods; PTR (peak time rebates) refers to customers being paid for load reductions on critical days; RTP (real time pricing) customers rates vary by the hour to reflect actual cost of electricity; CPP (critical peak pricing) customers pay higher prices during critical events; VPP (variable peak pricing) customers pay a rate that varies during alternative peak days to reflect dynamic variations in the cost of electricity

However, as explained before, LAC needs to improve the standard tariff *status quo* with a better grammar of tariff design.

Figure 2

LAC zone of immediate action in electricity tariff design



Source: Faruqui and Tang (2021)

Beyond this conservative reform view and with a more detailed focus, options for LAC look like an avenue for i) improving cost recovery through better wholesale market design and regulation; ii) move outside excess volumetric pricing and towards fixed charges and capacity charges; iii) reduce excessive block pricing; iv) promote metering and regulatory flexibility for menu pricing with optional schemes and guaranteed bills; v) promote flexibility for new customer clustering and pricing to accommodate innovation in the energy transition; vi) attend affordability through tariff schemes and transfers and move towards lump sum in social tariff schemes as a reform of (differentiated) fixed charges for low-income households; vii) introduce tax rebates for median income households; viii) reform taxation to coordinate among different jurisdictions.

6.3. Current energy shocks and electricity rate design issues

The international scenario has been shocked twice in 2020-22; first, with the COVID-19 pandemic and, more recently, with the Russia-Ukraine conflict, both with different implications for the energy transition and the accommodation to it of everything, including tariff structures. The last shock has been more relevant to tariff design dilemmas as it has brought affordability problems to Europe. However, in order to factor in this new shock into the discussion of electricity tariff design, one must distinguish between the origin and nature of the shock, on the one hand, and the propagation into tariff structures, on the other. The shock comes from the imbalances and pricing of primary energy inputs and not from the network tariffs themselves, which act passively. They are transitory, most presumably, price signals that disturb the grammar of electricity tariffs and significantly reduce their share in the final value of the bill, which is now the object of concern due to affordability issues. One must separate the potential effects of this shock between those that operate upstream in the electricity sector and those with downstream consequences. Among the first is the impact on marginal cost pricing and short-term spot prices and their effect on contracts. Among the latter are the consequences of shocks on the infrastructure components of pricing. The first effect is by far the dominant one in the current circumstances.

These sudden effects are essentially short-term and clearly should not converge in the long-term, that is, they are not here to stay. The long-term problems stem from another issue, which is whether the marginalist pricing model is going to survive in the long term as a model for price formation in electricity, given the volatility that it can generate and its consequences on socio-political sustainability, due to affordability. This volatility has always been thought, in the long term, as something with a technological root, that is, given by the volatility of renewables. However, the current debate is different and refers to whether the short-term shocks that are now being experienced are going to give rise to interventions that, in turn, leave consequences in price formation, with risks to prematurely abandon or reform the marginalist price formation model. It is in this sense that the short/long-term connection referred to above can be addressed.

Protecting electricity consumers from short-run cost and price shocks like the one recently experienced in the EU can be address from different angles that range from contracts design and lump sum transfers to other mechanisms that allow consumers to invest in purchase power agreements in order to hedge themselves (see Hirth, 2023). However, translated to the LAC institutional context hedging through PPA, investment does not seem practical and conflicts with affordability which is a prime constraint. The use of contractual design and lump sum payments seems more relevant. Even so, in LAC, we have an issue between transitory and permanent formats for the use of lump sum instruments.[8]

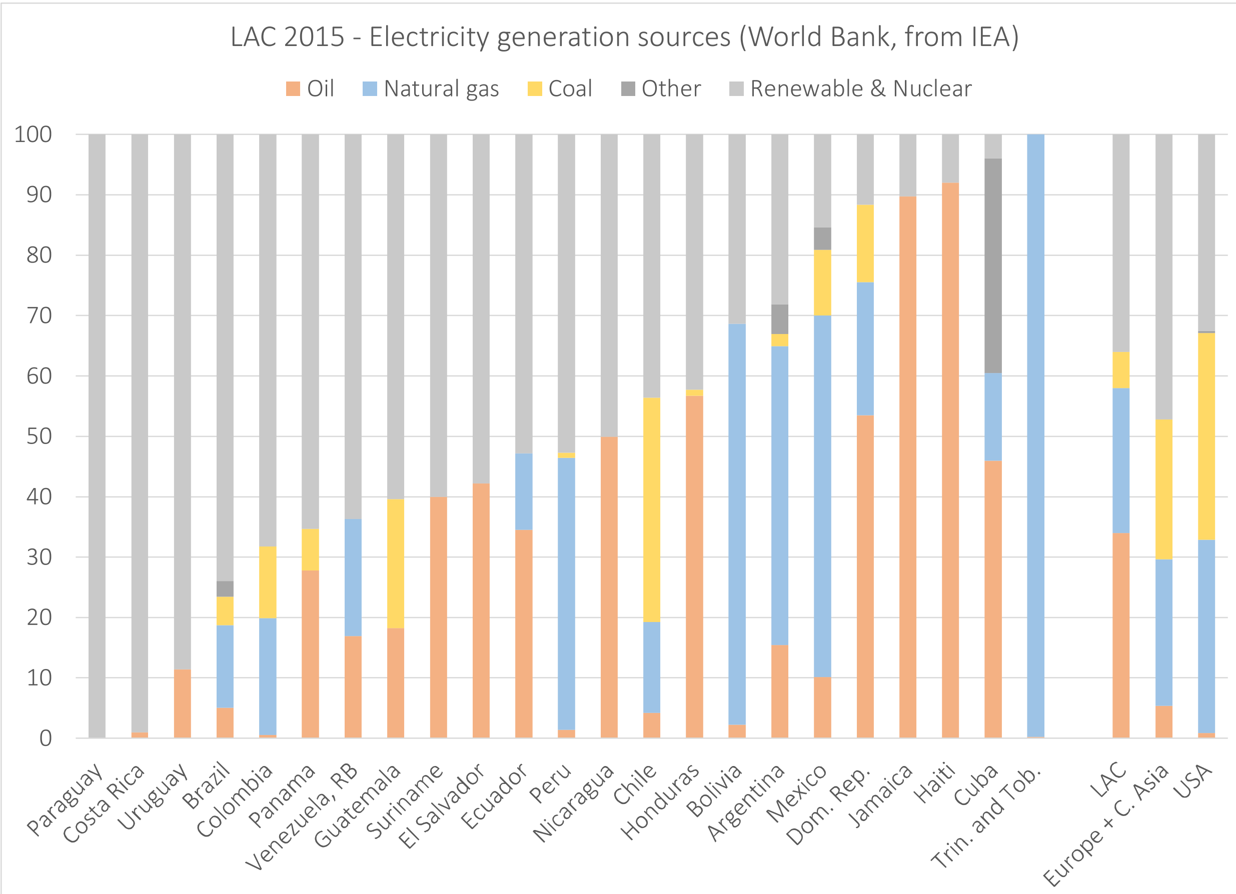
The debate concerning the consequences of upstream price formation in electricity is less demanding for LAC given that their wholesale electricity markets are less integrated, depend in some countries on a great deal of renewables, have autarkic pricing of natural gas and have a low contractual density compared to EU. Figure 3 shows the structure of energy inputs use in electricity generation across LAC and with a comparison to EU averages and the US. Primary evidence confirms/demonstrates that electricity prices have not escalated much in LAC, as they have done so in the EU. Gasoline and natural gas (or LPG) prices have

[8] The possibility that this can be used interactively with taxation is attractive. However, unlike what Hirth (2023) suggests for the EU, income taxation does not seem an effective available instrument in LAC and, instead, indirect tax excess burden seems more appropriate. Finally, the point that the lump sum transfers "cannot accommodate differences between individuals in consumption volume" depends on rate structure design and in practice could be implemented. Los antecedentes de las correcciones son singulars (burden y the point)

outperformed electricity prices (all measured in relation to the general price level) in some countries (Brazil, Chile) while controls or tax cushioning have avoided this in others (Argentina, Mexico). It is nevertheless an important issue to follow up the evolution of this crisis for its consequences on energy pricing structures.

Figure 3

LAC: Electricity generation energy input structure



6.4. Carbon pricing reform impact on electricity rates

In the case of LAC, it seems necessary to at least comment on the consequences or impact of the introduction of carbon pricing on the issues discussed in this paper. This seems important because of the likely consequences on energy costs, but also because current generation projects in the region do not seem conceived as taking into account that this tax is going to exist, as some documents in the IDB have recently brought up.

Evidence recently elaborated in Ahumada *et al* (2023) is summarized below in Table 8.

Table 8

LAC Effective Carbon Rates on Energy Use, 2018

country	*2018, in EUR/tCO_2*			
	Fuel Excise Tax	Carbon Tax	**Effective Carbon Rate**	*Electricity Excise Tax*
Argentina	17.18	1.46	**18.64**	*4.39*
Bolivia	20.02	0.00	**20.02**	*4.95*
Brazil	16.24	0.00	**16.24**	*5.26*
Chile	18.77	1.24	**20.01**	*0.00*
Colombia	19.68	1.72	**21.39**	*0.00*
Costa Rica	75.93	0.00	**75.93**	*7.66*
Dom. Rep.	24.61	0.00	**24.61**	*0.00*
Ecuador	0.00	0.00	**0.00**	*12.59*
El Salvador	17.95	0.00	**17.95**	*0.00*
Guatemala	6.86	0.00	**6.86**	*3.75*
Honduras	25.91	0.00	**25.91**	*2.83*
Jamaica	43.34	0.00	**43.34**	*0.00*
Mexico	28.28	1.28	**29.57**	*0.00*
Nicaragua	14.28	0.00	**14.28**	*3.06*
Panama	25.07	0.00	**25.07**	*0.00*
Paraguay	22.83	0.00	**22.83**	*0.00*
Peru	17.09	0.00	**17.09**	*4.14*
Uruguay	35.35	0.00	**35.35**	*0.00*
LAC simple average	*23.85*	*0.32*	***24.17***	*2.70*

Source: Ahumada et al (2023)

LAC position within the OECD carbon pricing metric, known as effective carbon rate (ECR, a methodology which adds up fuel excises, carbon taxes and carbon pricing coming from emission trading systems or ETS, all on energy use) gives an average of approximately 24 euros per tCO2, which is lower than the 45 euros of the OECD and which, as in the case of the OECD, is mostly explained by fuel excises in the road transport sector. For the rest of the sectors, including electricity generation (where a carbon tax on fuels should be located), there is practically no carbon pricing. This panorama does not change due to the current introduction of the carbon tax in the 4 LAC countries that have it (Argentina, Chile, Colombia and Mexico). In fact, the previous phenomenon is further aggravated in these countries, in terms of the low tax burden on CO2 outside the road transport sector. This is due to exemptions, for example in the case of natural gas and other fuels that have an impact on electricity generation, as shown before in Figure 3.

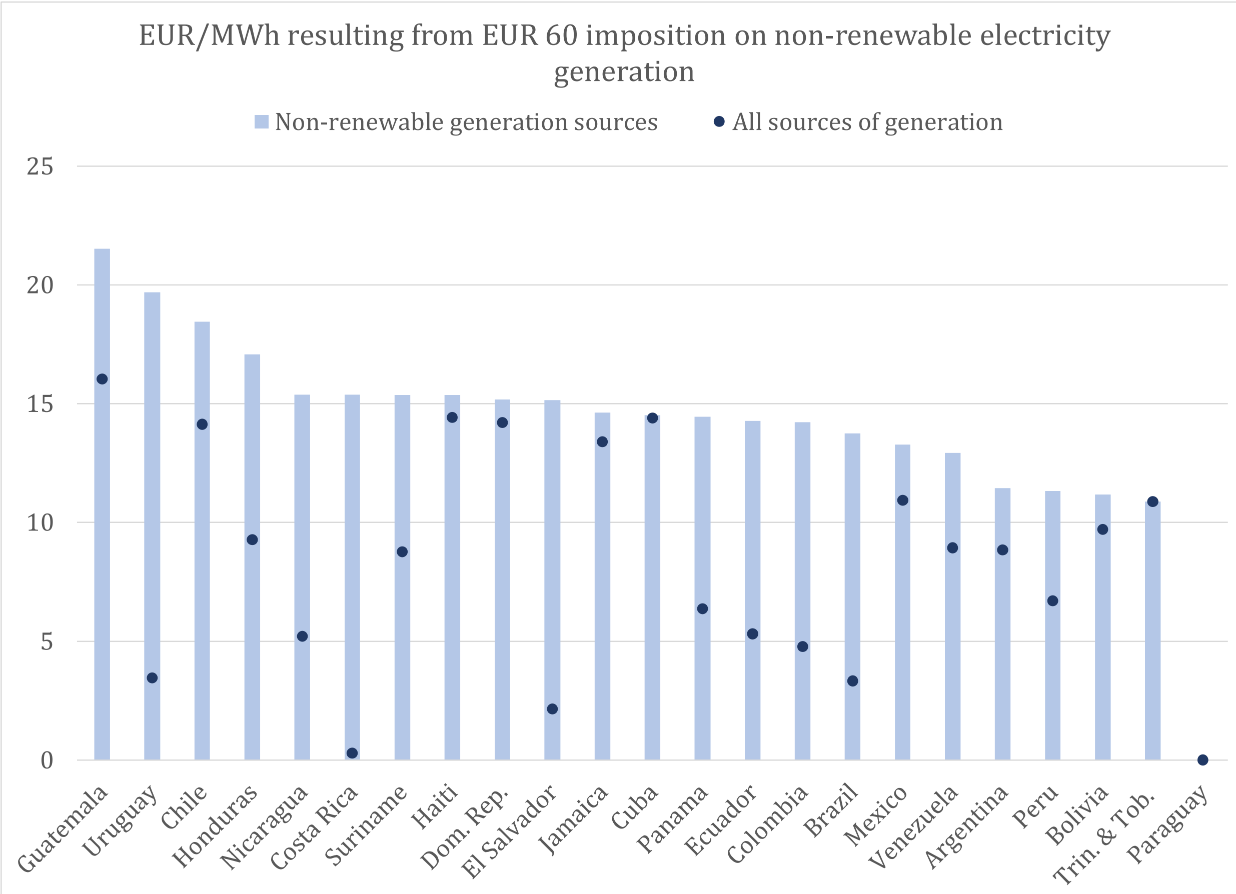
The last column of Table 8 shows another interesting feature of LAC which is the burden of excises on electricity use, whereby the final energy use of electricity (which does not emit

CO_2) faces a tax, while the fuel inputs used for generation are exempt from either excises or a carbon tax (in those countries where carbon taxes exist). Table 8 computes a hybrid ratio where the amount (in EUR) of excise taxes collected from electricity is divided by the quantity of CO_2 emitted in the electricity generation process. In other words, it shows the burden on electricity (energy) prices, per ton of CO_2, that the country already has; except that instead of being the result of a carbon tax on inputs is a tax on electricity use, that is, it shows a distortion. The size of this burden is important in some countries, particularly in Ecuador, which has zero effective carbon rates on energy use.

The impact of an introduction of carbon pricing in LAC on electricity prices can be approximated using the data collected in Ahumada *et al* (2023) and will of course depend on the assumption of the size of the carbon tax and the observed structure of electricity generation. Figure 4 provides a first approximation to such impact, assuming a carbon tax of 60 EUR per CO_2 ton, which is a mid-range value in the metrics for benchmarking used by the OECD. Figure 4 shows two different values. The bars report the amount, in EUR per MWh, of what would be a tax on CO_2 emissions per MWh generated by non-renewable sources. This is a ratio between the value of CO2 emission by different fuel inputs multiplied by 60 and the MWh generated from thermal sources. These values are, as expected, not very different across countries as inputs used in thermal generation across countries are relatively similar. Instead, the dot points in Figure 3 report the same taxed CO2 emissions per total MWh generated by the country. The more biased towards thermal units is the structure of electricity generation, the closer the points are to the top of the bars. Thus, countries with few thermal units and much more renewables, such as Uruguay, that rank similar to other countries in terms of impact cost per MWh of thermal generation, will show a significantly smaller impact on total MWh. Figure 4 shows that there exist 6 countries where a 60 EUR carbon tax will have a cost on electricity of about 15 EUR per MWh and another 6, with a cost impact of about 10 EUR. These are significant values, albeit manageable on a preannounced path. Carbon pricing would give a competitive advantage to renewable generation of the magnitudes suggested by this approximation, although a proper simulation needs to be modelled with a real dispatch model for each country.

Figure 4

Impact of a 60 EUR carbon tax on electricity costs in LAC



Source: Own estimates from Ahumada et al (2023)

7. Final remarks

While the previous section sets the discussion for what options ahead LAC has in terms of improving electricity tariff design from a given, we should not forget the objective of this paper insofar as contributing to a project whose scope is, in a first stage, essentially one of information gathering for ulterior purposes of providing such information for policy dialogue and policy research. While the discussion of where LAC should be moving in electricity tariff design -based on principles, international experience and own possibilities- emerges with force, there is a previous contribution on how to collect and understand the so much disorganized and heterogeneous data on electricity tariff setting that is dispersed across countries. What are the methodologies behind electricity tariffs in each country? Are they available? Are they transparent in informing tariff components and their correspondence with cost categories? What are the minimum standards that are needed in order to build a comparable set of tariff structures? How should countries cooperate in sharing methodologies and information on electricity tariffs? A project that helps solve these queries is by itself an important contribution.

The previous point is relevant also in another important dimension: Who drives tariff structure innovation today across the globe? Faruqui and Tang (2021) evidence tells a story that is essentially utility-driven (as the title of Figure 2 shows). This is relevant elsewhere but also in LAC, particularly concerning the role of distribution system operators (DOS) in tariff design progress. ACER (2021) EU account of the setting of electricity tariff methodologies shows a more balanced mechanism with country cases more biased towards Ministries, other towards Utilities and others towards National Regulatory Authorities (NRA). LAC has been moving towards giving a greater role to NRA, but the role of Utilities seems to have a potential, if proper governance can be implemented.

Addressing/In response to the question of which options LAC has available, in the previous section we provided an extensive list of actions within a workable zone of action for improvement. However, one important aspect to bear in mind is that there is no dominant-model-fits-all strategy or "pret-a-porter" blueprint and countries are in different stages and paths insofar as treatment of the trilemma and the tradeoffs. There are different political economy equilibria insofar as tariff reform structures are concerned.

There are nevertheless two main polar "models", depending on the role of tariff structures in coping with or responding to the affordability side of the trilemma. The first one is what may be termed a "*signal-efficiency model",* with main blocks being supported by *c*ompetitive wholesale market; incentive regulation 2.0; metering; two-part tariffs plus tariff packages and new tariff clusters; social marginal cost pricing; time of use; and, very importantly, lump sum fiscal subsidies to solve affordability. The second polar, rival one is what may be called a *"cross-subsidy model"*, with intervened wholesale markets; basic incentive regulation; block pricing; intra marginal price interventions; basic time of use tariffs; social tariffs or subsidies fundamentally embedded in pricing.

The way in which countries will locate between these two polar forms will be very much dependent on their fiscal and distributional performance. Fiscal performance seems essential to this discussion because the signal efficiency model is based on the assumption that fiscal transfers are available to solve the affordability, cost recovery, cost reflectivity trilemma. It assumes that fiscal instruments are available so as to decouple efficient pricing from lump sum transfers that accommodate affordability. If these instruments are not available, and the NRA does not have mandate or capacity to mimic lump sum fiscal policy through differentiated fixed charges, then the bias towards the cross-subsidy increases.

Regarding this issue, there is an ongoing critical observation of sectoral policy papers on infrastructure (electricity in particular). This suggests/contends/states that these studies normally recommend the use of fiscal instruments to solve the affordability problem, while it is very unlikely that these fiscal instruments will be available. Therefore, the problem should be considered within the sector. Confronted with the absence of fiscal space and instruments to accommodate compensatory transfers, one general reflection is that there is a need to consider, in practice, more or less distortive instruments or policies. More distortive are going to be those that lead to price blocks or schemes with cross subsidies that distort marginal prices. Relatively less distortive may be when the sectoral design tries to replicate or mimic fiscal policy. If it is desirable to deal with fixed-sum taxes/subsidies that alter fixed charges of bills and those instruments are not available, then the request is for the regulation to carry out this operation through differentiated fixed charges. This is going to be preferable to distorting marginal price signals. Setting compensatory transfers as a sectoral, regulatory supervised operation may be preferable on political economy grounds to centralize transfers through a fiscal operation, as fiscal transfers for electricity (and other infrastructure services) may be prone to political influences toward a universal basic income scheme when in reality we are in a transitory scenario due to a price shock which is above long-term energy values.

Following a sectoral approach to deal with affordability is relatively unorthodox because it will involve customer segmentation for these distributional purposes and, furthermore, the regulator will have to walk on tiptoes so as not to incur cross-subsidies. This is probably one area that needs further policy research. There exist some recent papers on electricity pricing (Burger *et al*, 2020) that insinuate the need for compensatory transfers to implement efficient time of use pricing but the issue is still undertreated. Beyond the use of differentiated fixed charges, which may not be enough to manage compensations, there are other fiscal instruments that can be studied as a coordination problem. This is the case studied in Navajas and Olguin (2022) commented in section 5, where we assume that there is room to reform taxes in a coordinated manner. The use of taxes can be used to add instruments that allow some subgroup of segmented, low-income have an automatic elimination of taxes, while others of low-middle and middle levels can access refunds ("rebates") by request. The use of these mechanisms is inferior to managing fixed charges because it affects marginal prices and if they are used loosely, they may give rise to leakages of transfers, a well-known problem in LAC, as documented in several IDB studies.

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APPENDIX A

PRIMARY SOURCES TO ASSESS ELECTRICITY RATE STRUCTURES IN LATIN AMERICA AND THE CARIBBEAN

Criterion: For each country, the relevant regulatory authority, an important or main utility and other relevant sources.

COUNTRY		ENTITY	source
1 Argentina	ENRE	Ente Nacional Regulador de la Energía Eléctrica	www.enre.gov.ar
	ADEERA	Asociacion de Distribuidoras de Energía Electrica de Argentina	www.adigas.com.ar
	EDENOR	Empresa Distribuidora y Comercializadora Norte SA	www.edenor.com.ar
	EDET	Empresa de Distribución Eléctrica de Tucuman SA	www.edetsa.com
2 Bolivia	AETN	Autoridad de Fiscalización de Electricidad y Tecnología Nuclear	www.aetn.gob.bo
	DELAPAZ	Distribuidora de Electricidad de La Paz SA	www.delapaz.bo
	ENDE	Empresa Nacional de Electricidad SA	www.ende.bo
3 Brasil	CCEE	Camara de Comercializacao de Energia Eletrica	www.ccee.org.br
	ELECTROBRAS	Centrais Eletricas Brasileiras SA	www.eletrobras.com
	FGV Energia	Fundacao Getulio Vargas Energia	https://fgvenergia.fgv.br/
4 Chile	SEC	Superintendencia de Electricidad y Combustibles	www.sec.cl
	ENEL Chile	Enel Chile	www.enel.cl
5 Colombia	CREG	Comision de Regulación de Energía y Gas	www.creg.gov.co
	ASOCODIS	Asociacion Colombiana de Distribuidores de Energía Eléctrica	www.asocodis.com
	ENEL	Enel Codensa	www.enel.com.co
6 Costa Rica	ARESEP	Autoridad Reguladora de los Servicios Publicos	www.aresep.go.cr
	ICE	Instituto Costarricense de Electricidad	www.ice.go.co
	CNFL	Comañia Nacional de Luz y Fuerza SA	www.cnlf.go.cr
7 Ecuador	ARCERNNR	Agencia Nacional de Regulación y Control de Electricidad	www.regulacionelectrica.gob.ec
	EEQSA	Empresa Electrica Quito SA	www.eeq.com.eq
8 El Salvador	SIGET	Superintendencia General de Electricidad y Telecomunicaciones	www.siget.gob.sv
	AES	AES El Salvador	www.aeselsalvador.com
9 Mexico	CRE	Comision Reguladora de Energía	www.cre.gov.mx
	CFE	Comision Federal de Electricidad	www.cfe.mx
10 Paraguay	ANDE	Administracion Nacional de Electricidad	www.ande.gov.py
	CLYFSA	Compañía de Luz y Fuerza SA	www.clyfsa.com
11 Peru	OSINERGMIN	Organo Supervisor de la Inversion en Energía y Minería	www.osinergmin.gob.pe
	ENEL	Enel Peru	www.enel.pe
12 Rep Dominicana	SIE	Superintendencia de Electricidad	www.sie.gov.do
	EDEESTE	Empresa Distribuidora de Electricidad del Este SA	www.edeeste.com.do
13 Uruguay	ADME	Administracion del Mercado Eléctrico	www.adme.com.uy
	UTE	Administración Nacional de Usinas y Transmisiones Eléctricas	www.ute.com.uy