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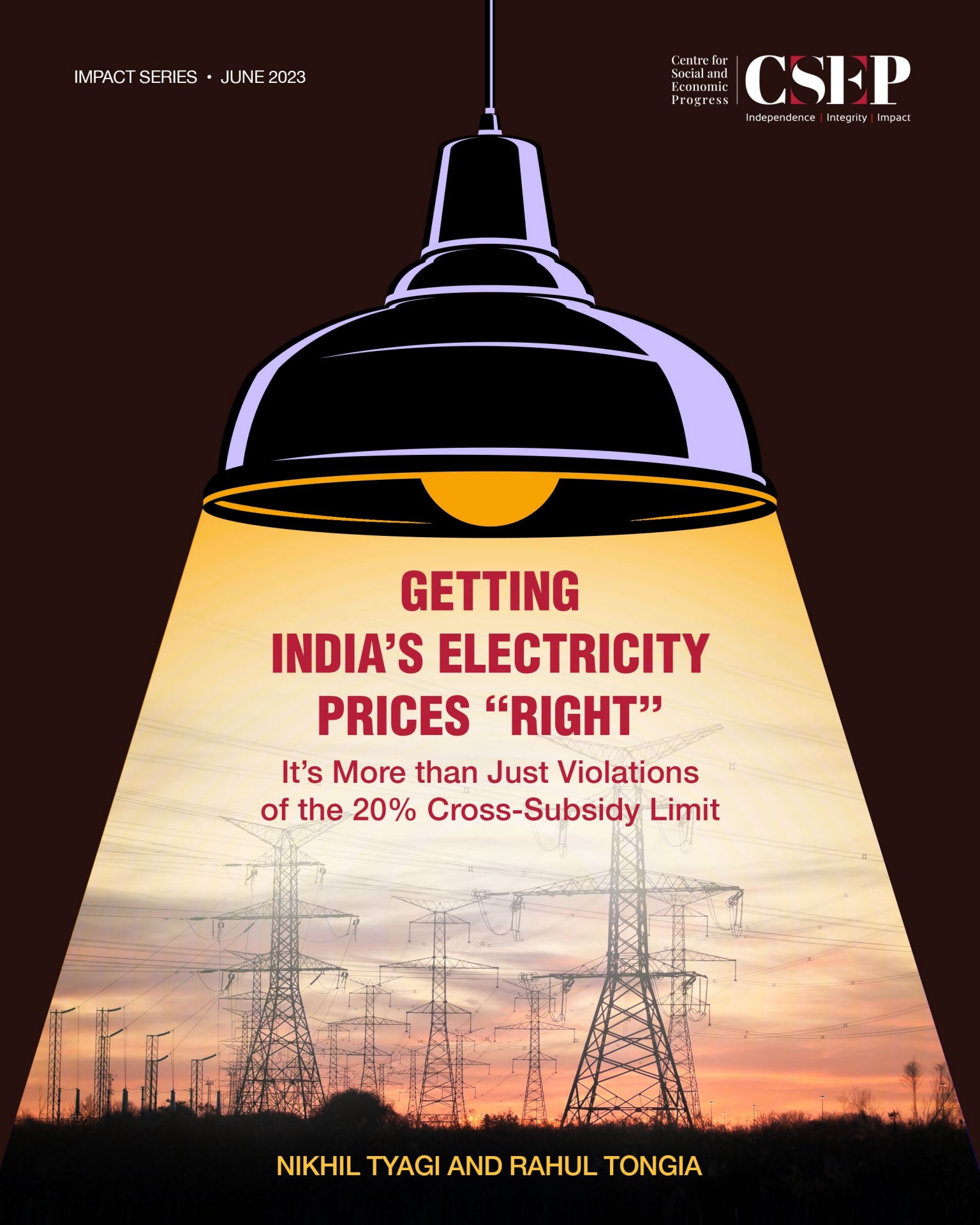

GETTING INDIA'S ELECTRICITY PRICES "RIGHT"

It's More than Just Violations of the 20% Cross-Subsidy Limit

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It's More Than Just Violations of the 20% Cross-Subsidy Limit

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List of Abbreviations and Terms

Δ	Delta (i.e., change)
ABR	Average Billing Rate
ACoS	Average Cost of Supply
APPC	Average Power Procurement Cost
APTEL	Appellate Tribunal for Electricity
ARR	Annual Revenue Requirement or Aggregate Revenue Realised
AT&C	Aggregate Technical and Commercial (loss)
BJ	Bhagya Jyoti (BPL scheme)
BPL	Below Poverty Line
CERC	Central Electricity Regulatory Commission
C&I	Commercial and Industrial
C-Loss	Collection Loss (Revenue loss from end-consumers)
CoS	Cost of Supply
CSS	Cross-Subsidy Surcharges
DisCom	Distribution Company
D-Loss	Distribution Network Loss (aka billing inefficiency)
E-Act	Electricity Act 2003
ED	Electricity Duty
FAC	Fuel Adjustment Charge
FoR	Forum of Regulators
FPPPA	Fuel and Power Purchase Price Adjustment
FY	Financial Year (Terminal year can be listed in shorthand. E.g., FY2018-19 = FY2019 = FY19)
GST	Good and Services Tax
HT	High Tension (aka High Voltage = bulk consumers)
KJ	Kutir Jyoti (BPL)
kVA	Kilo-Volt Ampere
kW	Kilowatt (measure of electricity *capacity*)
kWh	Kilowatt-Hour (measure of electricity *energy*)
LT	Low Tension (aka Low Voltage = smaller consumers)
MAT	Minimum Alternate Tax
MU	Million Units (aka Million kWh)

MYT	Multi-Year Tariff
NCLT	National Company Law Tribunal
O&M	Operation and Maintenance
PFC	Power Finance Corporation
PLF	Plant Load Factor (also called Capacity Utilisation Factor)
PPA	Power Purchase Agreement
PPC	Power Procurement Cost (also called Power Purchase Cost)
PSU	Public Sector Undertakings
R-APDRP	Restructured Accelerated Power Development and Reforms Programme
RE	Renewable energy
RoE	Return on Equity
SEB	State Electricity Board
SERC	State Electricity Regulatory Commission
S-loss	Subsidy non-payment loss
T&D	Transmission and distribution (loss)
ToD	Time of Day
UDAY	Ujwal DisCom Assurance Yojana (Central Govt. Scheme)
VCoS	Voltage-based Cost of Supply

Note: Please refer to Appendix C for DisCom and State abbreviations.

Executive Summary

Retail Electricity Pricing is a Delicate Balancing Act for Regulators

Electricity is one of the most important forms of energy in India, and is growing in share of total energy, especially as India strives to decarbonise. Until the late 1990s, integrated State Electricity Boards (SEBs) ran the entire electricity value chain. Over about 15 years, these were corporatised and mostly unbundled, creating separate public companies down the supply chain of electricity generation, transmission, and distribution (including consumer retailing). Almost all Distribution Companies (DisComs) remain State-owned, except for the few regions or cities that were historically private, or two States that privatised their State DisComs. Unfortunately, most DisComs, especially public ones, perennially suffer heavy losses, both of energy and of money. As DisComs are the last leg in the chain of electricity supply, their viability impacts the viability of the entire chain, and struggling DisComs are also a risk for India's climate change ambitions.

Distribution of electricity to consumers in India is a regulated service, with DisComs being offered a geographic monopoly over a region with regulated rate of return.[1] State Electricity Regulatory Commissions (SERCs) set consumer prices (aka tariffs) with two criteria in mind—to cover DisCom costs and to offer social welfare redistribution to protect the poor. The latter is through a system of cross-subsidies, where some consumer groups pay less and others overpay. This is distinct from any subsidies a State government may wish to offer, but such subsidies are meant to be outside the purview of regulators.

In this paper, we examine the processes and outcomes of regulatory tariff-setting, to see how well the criteria are met. In theory, as long as DisComs perform as per the operational targets set by SERCs, they should not be loss-making.

The SERCs are solely responsible for the process of retail tariffs, guided by the National Tariff Policy (which is enshrined in the Electricity Act 2003). The National Tariff Policy limits the cross-subsidy price variation for almost all consumer categories like households, industrial, commercial, etc. to ±20% of the Average Cost of Supply (ACoS). However, many regulator-set tariffs do not comply with the policy. In this paper, we quantify the non-compliance and examine possible causes and implications of the violations.

The process of setting tariffs spans several years and is broadly divided into two parts—*ex-ante* and *ex-post*. When setting initial tariffs *ex-ante* through the initial Tariff Order, the regulator must make a range of assumptions on power procurement costs, consumer mix, volumes of sale, etc. *Ex-post,* there are inevitably deviations from plans, which are meant to be reconciled through a subsequent tariff True-Up process[2]

[1] Only the city of Mumbai has retail competition with multiple DisComs that have overlapping geographic coverage. Throughout India, bulk consumers (above 1 MW in size) are allowed to choose their supplier through Open Access rules as per the Electricity Act 2003. They still need the DisCom's distribution network for last-mile connectivity.

[2] True-Up is the process of reconciling DisCom expenses based on *ex-post* audited reports and subsequent tariff petitions/ notifications. True-Ups disallow poor performance by DisComs, such as failing to collect dues from consumers, but there are a range of "allowed" *ex-post* changes for factors like changes in power procurement cost or in consumer patterns that the regulator should allow for recovery through subsequent tariffs. Such shifts are carried forward as part of the aggregate revenue requirement of the subsequent year.

that reconciles and compensates the Discom for legitimate gaps. We show that this is an important element of DisComs' financial performance.

Bottom-up Cash-basis Analysis of Revenues and Costs Shows a Worse Picture than Conventional Wisdom

This paper studies the entire chain and focuses on cash-basis accounting, which is distinct from the typical accrual-basis accounting followed in most official power sector documents and mandatory for corporate audited reports. Accrual accounting is based on booked values, which reflects the money that is promised or due, but the actual cash received is often much lower. Thus, our analysis shows a graver picture of DisCom finances.

We compare compiled governmental data sources with 60 DisCom Tariff Orders across India to quantify the costs and consumer-wise segment revenues. We calculate the cross-subsidies per segment after factoring in revenues from State government tariff subsidies. We also compare the *ex-ante* costs and revenues with *ex-post,* and apportion the changes across the respective stakeholders (DisComs, State governments, consumers, and regulators). We extensively use financial year 2019 (FY19) data as it was the latest available year for which audited annual reports data were available in the public domain at the time of analysis. This is also the last period not impacted by COVID-19, which has since, not only impacted sales but also consumer collection.[3]

Examining the regulatory process and finances, we find Tariff Orders (*ex-ante*) have virtually no losses, i.e., the expected revenues match the costs, but *ex-post,* there are significant changes, *ones that are mostly one-sided* and lead to a financial loss. Our analysis is per DisCom, which is important given the wide heterogeneity across India.

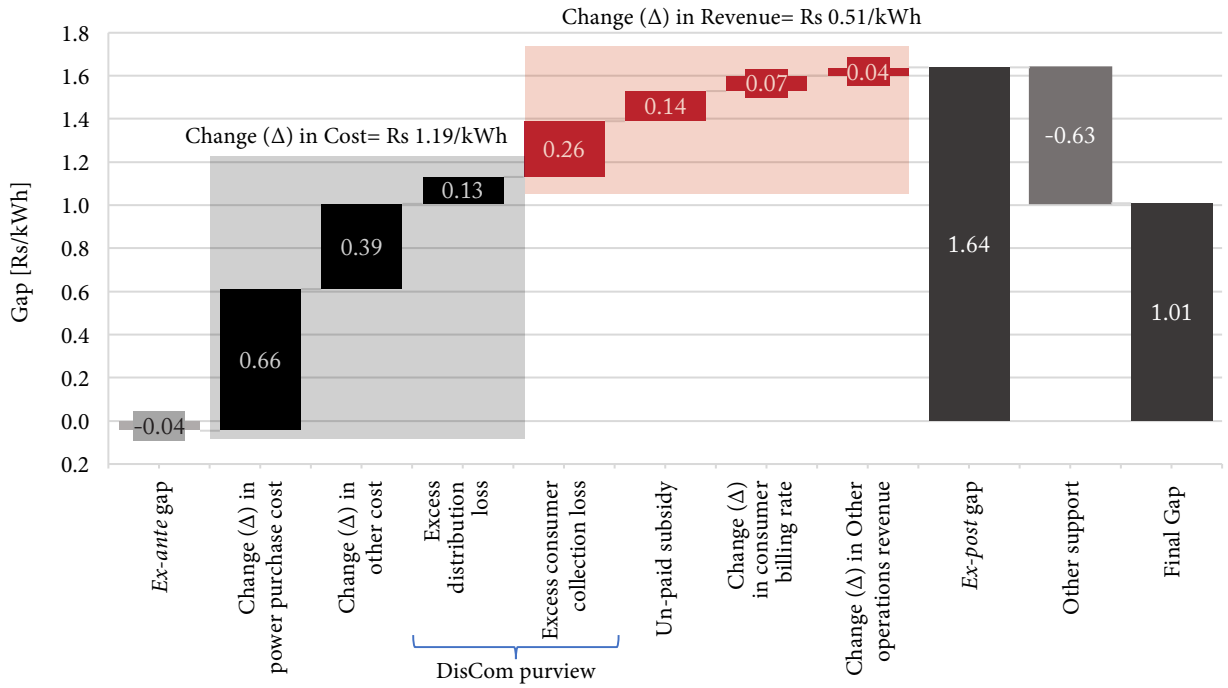
Even before considering changes in revenues and costs *ex-post*, the *ex-ante* Tariff Orders for FY19 set by regulators have more than 50% of electricity units with tariffs exceeding the ±20% cross-subsidy limit. To bring tariffs within compliance of the ±20% limit, a combination approach would be needed—lowering tariffs for some overpayers, and raising tariffs for some underpayers. For those paying below 80% of the ACoS, tariffs would need to rise by an average of Rs 1.17/kWh, which corresponds to a 30% increase from the prevalent tariffs. Such a rise is not easy when compared to the historical average tariff rise trend, which had a 5% compound annual growth rate (CAGR) over the prior five years (FY14-19), roughly in the range of inflation.

Ex-post, costs rise across most DisComs compared to *ex-ante* projections, by 19% on average. This rise in costs is paired with a fall in average billing rate (ABR, or revenues)—varying by DisCom. Put together, these change the finances from no losses *ex-ante* (actually, an average 0.5% profit, or 0.04 Rs/kWh) to a 22% gross financial gap for FY19 *ex-post*, or Rs 1.64/kWh financial loss. This gap is only partially offset by unplanned income and government grants (including Ujwal DisCom Assurance Yojana [UDAY] grants) of Rs 0.63/kWh, which lowered the net financial gap to 14%, or Rs 1.01/kWh. This shift in costs and revenues means the true cross-subsidy is even higher than as per Tariff Orders.

The *ex-ante* to *ex-post* change is substantial. There are multiple factors at play and stakeholders who are respectively accountable. These are broken down in Figure ES 1.

[3] The March 2020 lockdown impacted consumer collection for bills raised as early as February 2020.

Figure ES 1: All-India Change in Cost minus Revenue Gap from *Ex-ante* to *Ex-post* (cash-basis, FY19)



Source: Authors' analysis.

Note: The ex-ante gap starting as negative represents a mild surplus. Other support is a combination of government grants and unplanned income. This is calculated using cash-basis accounting (revenues as-realised), in contrast to the more typical accrual accounting (revenues as booked).

On the cost side, the largest change in absolute terms comes from an increase in power purchase costs, followed by a rise in "other costs" that are primarily financial and operational. Higher distribution network losses than the normative level as per Tariff Orders, also raise costs. Because of such distribution losses, which are a subset of the aggregate technical and commercial losses (AT&C), the DisCom needs to procure more power than planned to supply a given load. In aggregate, costs rose by Rs. 1.19/kWh.

On the revenue side, a substantial fall in cash revenues comes from DisCom failures to collect money from consumers, combined with non-payment of promised subsidies by State governments. Both of these are also components of AT&C losses. Some money is also not realised because regulators don't set a sufficient tariff, postponing a tariff rise by creating a "Regulatory Asset" instead where the utility doesn't get money in the current year's tariff. In addition, on average DisComs earned less than projected from the sale of power and other network charges (such as wheeling charges, open access charges, etc.). A significant part of this is due to a change in how many units of electricity are sold to which type of consumer. Put together, the average revenues on a cash-basis fell *ex-post* by Rs 0.51/kWh.

If we attempt to apportion responsibility for the changes, some factors could be considered

random, such as changes in consumption patterns, but a counter view is DisComs should do a better job planning and projecting demand. Without proper projections, they are also likely to get power procurement wrong, another cost ultimately borne by consumers.

Conventional wisdom holds the poor performance of DisComs as the cause of their financial losses, specifically high AT&C losses. However, only two components of AT&C losses—excess distribution network losses and consumer non-collection—are directly in the purview of DisComs. These losses were only 25% of the *ex-post* financial gap in FY19. Non-payment of subsidies—officially part of AT&C losses—was due to the State government and was 8% of the financial gap. Even put together, addressing such causes of the gap will not close the overall financial gap that DisComs face.

Most other components that shifted should, in theory, be reconciled through the True-Up process. Even if such *ex-post* financial gaps were to be recovered, these would take several years to materialise. More importantly, we found that True-Ups only capture a small fraction of *ex-ante* to *ex-post* differentials even focusing just on "allowed" differentials that aren't based on the fault of the DisCom or other stakeholders like the State government (in case they don't pay promised subsidies in full). In FY19, Tariff Orders embedded just 0.07 Rs/kWh of historical True-Ups as part of the cost structure, or close to only 1% of costs. A complementary paper by Devaguptapu and Tongia (2023) examines such issues over a 15-year time series.

Fixing the Gap And Cross-subsidy Limits Will Ultimately Require a Tariff Rise

Improved operations (e.g., lower AT&C losses) are welcome and important, but will only address a small portion of the financial gap. Closing the gap will require wide a range of steps, including better planning and a streamlined True-Up process. However, the ultimate need will be for higher tariffs than the present *ex-ante* tariffs, but higher tariffs are unwelcome across the spectrum of consumers and State governments.

Higher tariffs will also be required to keep cross-subsidies within statutory limits. This is a pressing issue not just to comply with the law but also because a system with excessively high prices for so-called "paying customers"—primarily commercial and industrial users—creates several challenges. First, this hampers economic growth and global competitiveness. Second, the growth of such consumers is lower than the growth in sales volume we see from lower-end consumers, putting pressure on the redistribution equilibrium. Lastly, thanks to both technological and regulatory changes, such paying customers are the ones most likely to exit or at least diminish their offtake from DisComs through a combination of self-generation, such as rooftop solar and third-party sales like under Open Access norms.

Fixing the financial gap through improved tariffs is also critical because cash strapped DisComs are forced to rely on a range of coping mechanisms that include delaying payments to their own suppliers, including generators. This propagates upwards all the way to delayed payments for coal, railways, and, ultimately, the banking sector.

If we dig deeper, true cross-subsidies are likely higher than most calculations show. Present norms and our base analysis calculate cross-subsidies based on the ACoS, but the true cross-subsidies are likely even higher if we properly account for differences in cost to serve. Bulk consumers ("high tension" or HT consumers) are cheaper to serve, and so if we re-calculate

cross-subsidies with such data (available for a few states), we find an even higher cross-subsidy. We can also estimate differences in costs to serve by using retail electricity pricing data from the United States (US), across consumer categories, where industry has the lowest tariffs, followed by commercial, and with households paying the most. Recalculating cross-subsidies based on such differential costs to serve, would raise the levels of cross-subsidies by tens of percent.

There are a range of steps that should be taken to help the tariff process, distinct from setting more cost-reflective tariffs. DisComs clearly need to lower AT&C losses, but we also need far better operational and financial data, especially on the revenue side. We need more standardisation of consumer categories, slabs, etc., and more granular breakdowns within AT&C losses. This is important because different components of AT&C can only be fixed by different instruments—better management versus investments in the physical network. Even billing today isn't as scientific as one would expect. It is well known that many irrigation pumpsets are not metered, instead relying on assumptions for measuring agricultural supply. This creates the space for fudging data (and hiding losses) and simultaneously asking for more subsidy, given agricultural supply is often subsidised by the State. What is less understood is how many other consumers don't have proper monthly billing—many residential consumers only get estimated bills, that too inconsistently. The planned rollout of smart meters should help this process.

Regulators have the ultimate responsibility for setting tariffs right, but DisComs also have a strong role to play. Improved planning would not just help to set prices right (where plans should more closely match actual realisations) but also lower costs by optimising generation procurement and network investments. Proper pricing, which may require increasing tariffs, needs cross-stakeholder support, especially from the State government. There is a limit to how much State governments can subsidise consumers, and the interplay between subsidies and cross-subsidies is a hidden barrier to rationalised tariffs. Artificially low regulator-set tariffs for subsidised consumers (like agriculture) may reduce the subsidy burden on the State, but this just means either someone else is paying, or that the DisCom bears the brunt of any leftover gap, more so in the *ex-post* financial realisation. The present equilibrium of both cross-subsidies and high *ex-post* losses cannot be sustained and needs prompt rectification.

Abstract

In India, consumer electricity prices are set by independent electricity regulators who try to keep the electricity provider (the distribution company, or DisCom) financially viable, while balancing consumer interests. As a form of social welfare redistribution, consumer tariffs (retail prices) have cross-subsidies, where select categories of consumers overpay (typically commercial and industrial users), while some groups underpay (agricultural and domestic). Cross-subsidies are distinct from any explicit subsidies that State governments may choose to provide, which in recent years, can be 15-17% of the total DisCom revenue generated. Consumer tariffs also typically follow progressive tiered (slab) pricing, where higher consumption—expected to be linked to higher consumer wealth—is charged at a higher rate.

In this paper, we examine the equilibrium of retail pricing, beginning with the question whether prices are in compliance with the Electricity Act 2003 enshrined National Tariff Policy, which states that cross-subsidies should be limited to ±20% of costs. This is widely interpreted to mean prices for consumer *categories* compared to the Average Cost of Supply (ACoS). We also examine if there is any gap between costs versus revenues, both *ex-ante* (when regulators set tariffs) and *ex-post* (based on the actual cash-basis realisations), and the causes of gaps between costs and revenues (if any).

We quantify non-compliance of the cross-subsidy limit through a first-of-a-kind analysis that examines Tariff Orders individually, which are *ex-ante*, instead of the revenues *ex-post* that the Power Finance Corporation (PFC) compiles annually. We find that the cross-subsidy is well outside the prescribed ±20% limit for over half the units sold all-India, more so for underpayers than overpayers. For selected classes of consumers (predominantly Domestic and Agricultural), compliance would require an average rise of about 30% of their tariff.

Analysis shows that the *ex-ante* Tariff Order pricing virtually matches expected costs with revenues, but the *ex-post* revenues as-realised show heavy financial losses. These are losses we calculate on a cash-realised basis, instead of the accrual-basis accounting normally reported. Much of the change from *ex-ante* zero-gap to *ex-post* high losses is from higher costs than assumed, with modest declines in revenues on average. The losses remain even after normalising for DisCom non-performance such as higher aggregate technical and commercial (AT&C) losses. Such a change, especially the rise in costs, further exacerbates cross-subsidies.

Of the reasons for variance between Tariff Order rates and as-realised average prices, we find that DisCom non-performance (such as high AT&C losses) only explains about one-quarter of the direct gap for FY2018-19. Within AT&C losses, non-payment of promised subsidies is in the hands of the State government and is thus not the fault of the DisCom. Other explanatory factors like higher-than-planned cost for power purchase, which is the biggest single factor, are meant to be recoverable over time given costs-plus regulations. Even if all such causes of variance were recovered in future years (through the True-Up *ex-post* reconciliation process), this carries a significant carrying cost for the DisCom. We also find that True-Up reconciliation doesn't recover all allowed changes that aren't the fault of the DisCom. We posit that insufficiently set regulator tariffs and other process-related factors explain the rest of the *ex-post* financial gap.

Considering several policy options for compliance with cross-subsidy rules, the simplest would be to modify (raise) tariffs—but this may be politically difficult. There are also steps to be taken that don't require raising tariffs. Improving operational performance is ostensibly in DisCom hands, but almost half of non-collection from consumers is reportedly from governmental consumers who don't pay. Reducing consumer non-collection would require a range of operational fixes, ranging from increasing up-front deposits to using smart meters that can not only improve meter readings but also disconnect errant consumers. Smart meters can also operate in a prepaid mode, which has proven popular for mobile phone service, but has yet to be embraced widely in the power sector. We also examine the intersection between cross-subsidies and subsidies. For instance, in the cases where the consumer category enjoys both subsidies and cross-subsidies (such as Agriculture), higher cross-subsidies that lower the tariff also reduce the exchequer subsidy burden.

Introduction

Most electricity supply in India is presently based on an unbundling of the erstwhile vertically integrated State Electricity Boards (SEBs), where there are now separate entities for Generation, Transmission, and Distribution. Generation is now heavily competitive, with significant private sector participation as well.

Distribution, which in India also includes the retail component and not just the wires side of the business, is mostly a regulated monopoly. Independent State Electricity Regulatory Commissions (SERCs) are meant to set consumer tariffs (i.e., retail prices) that are "cost-reflective". Unfortunately, Distribution Companies (DisComs) have been loss-making for years. Conventional wisdom is that this is because of the poor operational performance of DisComs.

Regulators are meant to balance supplier economic viability with consumer interests. The latter is often viewed as "low prices", but such a metric ignores quality of supply.

In this paper, we study how well this balance is met. We examine notified consumer prices (tariffs) as well as the tariff-setting process to determine what are the causes for any financial loss of DisComs, and how different consumers are treated in terms of pricing.

Getting the prices right is a complex and nuanced process. Electricity in India is a delicate (and often failing) balance between its commodity aspects and its treatment as a public good. The pressure for low prices, when exerted incorrectly, results in losses for the provider (the DisCom). Getting the prices right will be critical for viable DisComs, as they are key to not just India's development objectives but also its climate change mitigation ambitions which disproportionally go through the electricity sector.

Our study is broken into six parts. First, we cover the background of the tariff-setting process in India. We use selected states as detailed examples, but focus on the aggregate (all-India) picture. Sub-components of this include the steps or stages or the process, in addition to the legislation and rules that guide tariff-setting.

Next, we present a literature review to understand what has been studied in the past. This not only builds a base for our analysis but also sharpens the differences compared to our objectives and methodology, which is section three.

We then share our findings, split between *ex-ante* Tariff Orders and *ex-post* revenues as-realised. In the fifth section, we discuss implications and key factors that matter, including nuances of interpretation of the rules and methodologies. Lastly, we present policy recommendations for improving consumer tariffs, including at a process level.

Our study has two primary objectives and two parts as well, covering each stage of the process (*ex-ante* and *ex-post*).

Our objectives are to:

(1) Understand cross-subsidies in the tariff process:

   a. Aggregate quantification of cross-subsidies;
   b. Granular breakdowns of the cross-subsidies at consumer category and DisCom level; and
   c. Price changes required to comply with the norms for allowed cross-subsidies.

(2) Examine the overall financial picture of DisComs, comparing costs versus revenues:

a. If there is a gap in costs minus revenues, understand the causes of the gap.

The two parts of the study are to examine the above objectives at each stage of the tariff process (further detailed subsequently):

(1) At the Tariff Order stage where regulators set the tariffs (planned or *ex-ante*); and

(2) Based on actual operations and financials (as-realised or *ex-post*).

This paper is unique because of its methodology that covers virtually all the DisComs across India while comparing *ex-ante* (plans) with *ex-post* (as-realised actual) numbers. We also breakdown the causes of any changes between *ex-ante* and *ex-post* across stakeholders. We also focus on cash accounting, instead of the normally reported accrual accounting (i.e., finances as booked).

Much of this paper focuses on cross-subsidies, not merely because of the government rules governing these, but because these are also a critical component of overall social-welfare redistribution. It's not just a simple policy (or political) choice on who should pay how much, even assuming on average the DisCom recovers costs. Because of the slew of ongoing energy transitions, getting the prices right is critical not just for keeping the DisCom viable but also for maintaining the social-welfare redistribution equilibrium in balance while the underlying market, technology, and regulatory landscape is shifting.

As we expect a rise in end-user renewable energy (RE) generation (as from rooftop solar) the present system of cross-subsidies means the cream of consumers have the greatest incentive to exit the system. Incentive to exit not just from rooftop solar but also to choose from rising availability of alternate suppliers, instead of the incumbent DisCom. Market and competitive shifts include options such as captive power generation and third-party generation with Open Access (the rule in the Electricity Act 2003 that allows bulk consumers to choose any supplier who can use the DisCom's wires for last mile access, at a regulated cost).

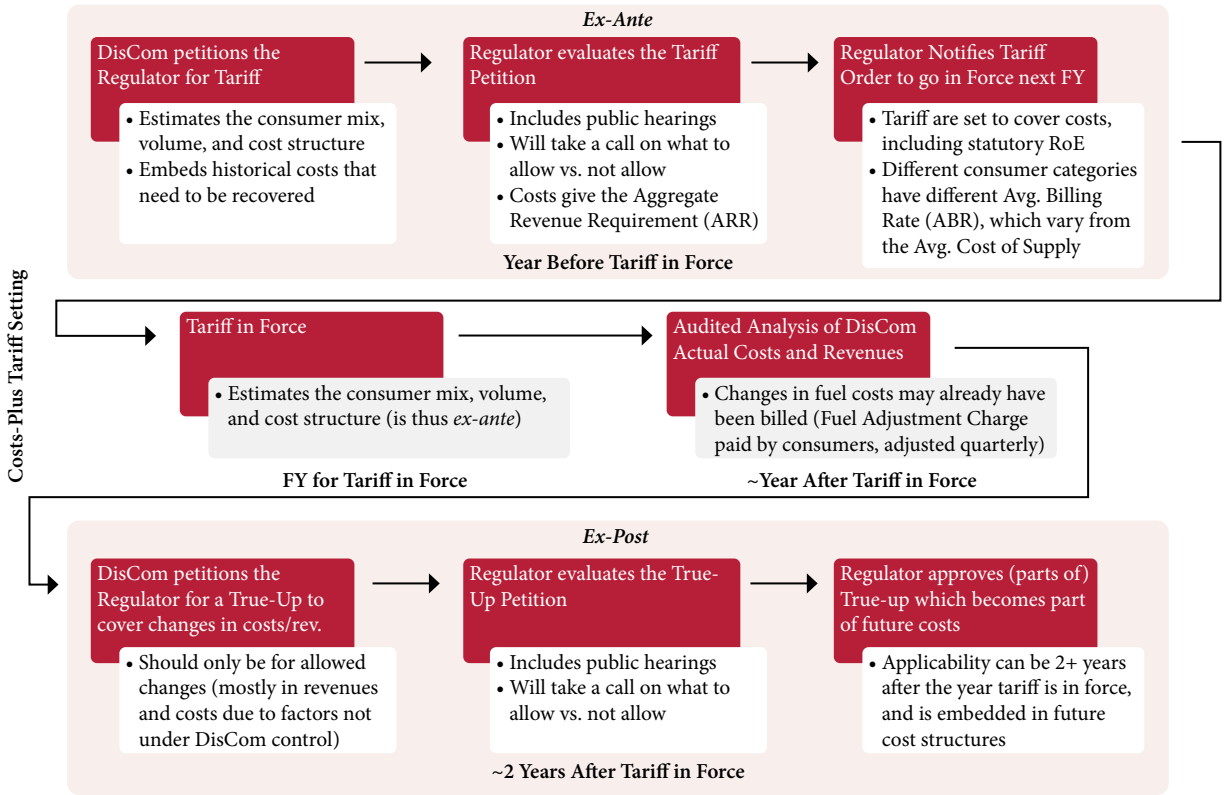
DisComs have necessitated multiple rounds of bailouts over the last two decades, which haven't fixed the problem. For the reasons given above, the pressure to fix their financials will only grow over time. This paper is a step towards understanding the root causes of any financial gaps.

Consumer Tariff Setting Process: Costs-Plus Regulated Pricing

Electricity distribution utilities or companies (DisComs) in India are almost always monopolies for a given geographic coverage,[4] and they enjoy costs-plus regulated returns. The SERCs set consumer retail prices (tariffs) such that the DisCom covers costs and garners a statutory rate of return on equity. If all goes as planned, DisComs should never make a loss. But we know that most DisComs have been loss-making for decades. We aim to examine why DisComs have financial losses, and which stakeholders are responsible for any such losses.

Figure 1 shows the tariff-setting process for retail electricity consumers.

Figure 1: Regulatory Tariff-setting Process – Spans Several Years



Source: Authors' analysis.

Note: Most states deploy Multi-Year Tariff (MYT) processes to give guidance, but any specific year's tariff is adjusted based on the above process. The last step in the above process feeds into the first step of a future process, typically two years later.

[4] Mumbai is the only region of India with retail competition for consumers. The vast majority of Indian DisComs are 100% public sector units (PSUs) owned by state governments. Per FY2020 data from Power Finance Corporation (PFC), public DisComs or state electricity departments covered 94% of kilowatt-hours sold.

While there are a range of steps for the process, there are four key takeaways for the process:

1. *Ex-ante* processes are based on inevitable assumptions, but there is also a range of decisions taken by the regulator in what costs to allow (or not allow). Some assumptions are not directly in the hands of the DisComs, such as the consumer mix, or even power procurement costs (PPCs, which are based heavily on legacy contracts), but others are ostensibly the DisCom's responsibility, such as operational performance. The key marker for performance is the operational loss, captured as Aggregate Technical and Commercial (AT&C) losses—a hybrid measure of both energy and financial performance. The AT&C is discussed in more detail subsequently.

2. The allowed costs—captured as the Annual Revenue Requirement—are meant to recover costs that include a statutory rate of return. Thus, a "breakeven" performance (revenues = costs) is actually profitable to the extent there is a Return on Equity (RoE) embedded in the cost structure. The total costs (the Annual Revenue Requirement, or ARR)[5] are covered through prices that vary by consumer type. Some consumer segments overpay (typically Commercial and Industrial), while others underpay (mostly Residential [Domestic], and Agricultural). Such cross-subsidies are distinct from subsidies a state may wish to offer, which are ostensibly meant to be outside regulator purview. While the majority of revenues come from sale of power, a small fraction of revenues is meant to come from other operations that the regulator recognises, such as network access charges for third-parties who sell to bulk consumers.

3. The true picture of what transpires *ex-post* invariably differs from *ex-ante* plans due to changes in costs (Average Cost of Supply, or ACoS), changes in Average Billing Rate (ABR), and changes in consumer mix (e.g., selling less or more to different types of consumers).

4. Based on the change between *ex-ante* and *ex-post*, DisComs file a True-Up petition to recover allowed changes in costs or revenues. Given the need for an audited report of *ex-post* financials, and a petition process, any True-Up allowed by the regulator takes at least two years to come back to the DisCom. True-Up values are treated as additional (or, rarely, lower) costs as part of future year cost structures. We examine this issue in more detail subsequently.

In cases where DisComs fail to submit a tariff petition on time, SERCs can issue *suo-moto* tariff orders, otherwise prior tariffs continue. Given continued inflation, the latter inevitably leads to losses for the DisCom.

We take Karnataka's Bangalore Electricity Supply Company (BESCOM) as an example to illustrate the major components of expenses (Table 1). The costs span power purchase costs, operation and maintenance (O&M) including manpower, interest costs, return on equity (RoE), taxes, depreciation, and a small portion for other costs. These components can have further bifurcations not shown above, for example, for power procurement, where many Power Purchase Agreements (PPAs) segregate fuel costs.

[5] The term ARR as used by Regulators, is distinct from government documents such as PFC (2021), which define ARR as Aggregate Revenue *Realised*. Context is important for distinguishing between the two.

Table 1: BESCOM Costs and thus Annual Revenue Requirement (ARR) per FY19 Tariff Order

	Particulars	Amount (Rs crore) (unless otherwise specified)
1.	Power purchase cost (PPC, including the cost of transmission)	16,000
2.	O&M expenses	1,653
3.	Total interest and finance charges	947
4.	Others (RoE with minimum alternate tax (MAT), Fund towards Consumer Relations, etc.)	400
5.	(Gross) Annual Revenue Requirement	19,006
6.	Deficit carried forward from the previous year (FY17)	234
	Net Annual Revenue Requirement	**19,236**
	Energy sales (Million kWh)	**28,286**
	Average cost of supply (ACoS) (Rs/kWh)	**6.80**

Source: Karnataka Electricity Regulatory Commission, 2018.

We note that the average is simply total rupees divided by total volume of sales, but both of these are heavily assumption-based.

This Cost of Supply or CoS (6.80 Rs/kWh) and commensurate revenue requirement (Rs 19,236 crore) is then apportioned across consumers (Table 2), where an average revenue per consumer group is set based on the assumed volume per category and principles of social welfare redistribution, typically by under-charging agriculture and most residential ("domestic") users.

There are many categories of consumers, and some are further split between smaller or bulk consumers. For our analysis, we try and standardise consumer categories across DisComs based on the Tariff Orders and their listed assumptions, e.g., placing "mushroom growing" (separate in some DisComs) within Agricultural (since it also enjoys discounted tariffs compared to the average in most cases). For Residential (i.e., Domestic), we combine low-tension (LT) and high-tension (HT) consumers (smaller and bulk connections shown separately for BESCOM), and do the same for Commercial, Industrial, and Agricultural users, which together are the vast majority of units sold.

As Table 2 shows, a large fraction of consumer categories have a revenue structure (ABR) that has a cost coverage below 80% or above 120% of the average cost, thus violating the National Tariff Policy which limits cross-subsidies. This is true across most DisComs.

The ABR includes both fixed and variable charges for a consumer. Fixed charges are typically based on sanctioned load size (in kW or kVA), while variable charges are also termed energy charges or consumption charges.

Table 2: BESCOM Category-wise Revenue and Cross-subsidy per FY19 Tariff Order

Consumer Category	No. of consumers	Sales (Million kWh aka Million units)	Revenue (Rs crore)	ABR (Rs/ kWh)	ABR Coverage vs. Average Cost (%)
Smaller consumers (low voltage or low tension)					
LT-1a BJ/KJ: up to 40 units*	893,434	128	87	6.80	100%
LT-1b BJ/KJ: more than 40 units		48	22	4.62	68%
LT-2a Domestic	7,695,924	7,139	4,186	5.86	86%
LT-2b Private/Professional educational institutions, private hospitals, and nursing homes	11,721	52	42	7.93	117%
LT-3 Commercial lighting, heating, and motive power	1,074,420	2,191	1,967	8.93	132%
LT-4a Irrigation pump sets ≤10 HP*	895,379	7,123	2,636	3.70	54%
LT-4b Irrigation pump sets > 10 HP	611	3	1	4.53	67%
LT-4c Horticultural nurseries, coffee, tea, and rubber plantations	1,524	6	2	4.22	62%
LT-5 LT Industries	204,391	1,191	976	8.20	121%
LT-6a Water supply	78,805	935	502	5.37	79%
LT-6b Public lighting	63,520	453	329	7.26	107%
LT-7 Temporary supply and permanent supply to advertisement hoardings	647,892	166	215	12.94	190%
Larger consumers (high voltage or high tension)					
HT-1 Water supply and sewerage	232	702	404	5.75	85%
HT-2a HT Industries	6,614	4,929	4,066	8.25	121%
HT-2b HT Commercial	6,095	2,624	2,656	10.12	149%
HT-2c Hospitals and educational institutions	718	365	293	8.02	118%
HT-3 Lift irrigation schemes under government departments/Government-owned corporations/Lift-irrigation schemes under private societies	45	18	5	2.73	40%
HT-4 Residential apartments/Colonies	199	110	75	6.79	100%
HT-5 Temporary supply	1,092	104	178	17.18	253%
Miscellaneous revenue (revenue from other operations)			594		
Total		**28,287**	**19,236**	**6.80**	**100%**

Source: Karnataka Electricity Regulatory Commission, 2018.

Note: LT includes low tension (or low voltage), while HT is high tension (bulk consumers). BJ/KJ are Bhagya Jyoti/Kutir Jyoti schemes for Below Poverty Line (BPL) consumers. Colour-coding—Yellow (0%-80%); Light grey (80%-100%); Dark grey (100%-120%); Red (>120%)—is to show category-wise ABR cost-coverage compared to the DisCom ACoS. HP = Horsepower (measure of connection size).
**Denotes a subsidised category for which the State pays part or all of the notified tariff (ABR) indicated in the table.*

Energy prices or tariffs aren't fixed even within a consumer category, instead following progressive telescopic tiers or slabs based on the volume of consumption, similar to income tax. Many other countries follow the same kind of structure (formally known as an increasing differential block tariff structure, with some alterations according to the supply and demand profile. For domestic (residential) consumers, 60% of countries use some form of increasing differential block tariff structure (Foster & Witte, 2020).

This is yet another laying of assumption-based planning when setting tariffs, not shown here, which leads to further cross-subsidies *within* a consumer category, which we revisit subsequently. Because of inherent cross-subsidies, assumptions on sales volume per consumer category can have a strongly non-linear impact on revenues.[6]

Based on the process of determination of costs and apportionment of costs into retail tariffs, Table 3 shows the aggregated all-India snapshot of costs and revenues per unit (per kWh) sold.

Table 3: All-India Tariff Order Cost and Revenue Summary

	Rs/kWh
Tariff order cost	6.27
Tariff order revenue from sale of power	6.14
Tariff order revenue from operations	0.07
Tariff order total revenue	6.21
Subsidies taken cognisance of when setting tariffs	0.10
Gross gap from tariff orders	0.06
Net gap, including subsidies embedded when setting tariffs	(0.04)

Source: Compiled from respective DisCom Tariff Orders.

Note: The averages are based on the sample of 48 DisComs. The total cost of supply in FY19 as per PFC was 7.4 Rs/kWh.

A negative gap means a surplus.

[6] End-user taxes or electricity duty (ED) are not part of this analysis as they are outside regulator purview, and are meant to be paid to the state government. In practice, ED as collected is sometimes offset at the end of the year with the subsidy the state government is meant to pay. However, in most states ED rates are low, and lower than state subsidies.

Differences Between *Ex-ante* and *Ex-post* are Meant to be Reconciled via a True-Up Process

The regulatory process, by design, recognises that *ex-post* financials can and will differ from *ex-ante* plans, and allow for reconciliation via the True-Up process, which is the bottom row of Figure 1. In this sub-section, we focus on a range of process details, focusing on how well the process is set up, and how well it works.

The overall variations can be driven by change in any component of the assumptions, spanning procurement costs, expected system losses, consumer mix/volumes, etc. But not all components are equally at risk of changing, nor are their impacts comparable.

The AT&C losses are notionally specified by the regulator, but in many instances the DisCom is unable to comply. This would lead to reduced earnings, but such changes due to failures of performance from *ex-ante* to *ex-post* are not meant to be covered through the True-Up process.

The True-Up process is meant to only cover financial changes between *ex-ante* and *ex-post* that are allowed by the regulator (thus, should exclude any faults of the DisCom), and are meant to be addressed through a future tariff rise (or fall, if applicable). For the BESCOM example FY19 Tariff Order (Table 1), this is listed as point 6, the "Deficit from FY17 carried forward", which was an *ex-post* deficit in FY17 revenues. Note that this is just over 1% of the total costs in the BESCOM example.

While Karnataka regulators recognised past (FY17) costs that needed Trueing-Up into the cost structure of a later year (FY19), in some cases regulators recognise the need for cost recovery but don't add such costs into the rate base, avoiding the corresponding tariff rise. Such money is dubbed by the euphemism "Regulatory Income" in the Tariff Order, which is a booked income not actually realised by the DisCom on a cash basis. It shows up in the balance sheet as a "Regulatory Asset" to be recovered in the future with subsequent tariff rises. In BESCOM's case, all the FY17 True-Up was allowed as part of the FY19 cost structure with a corresponding tariff increase.

Regulator-Sanctioned Cross-subsidies are Limited by Law

Cross-subsidies are an instrument for social welfare redistribution, but government rules limit how much can be applied while setting tariffs. Such cross-subsidies are distinct from explicit subsidies the state government may choose to offer. In theory, the regulator should be agnostic to any subsidies by the state government, which would simply substitute some portion of consumer payments with taxpayer money. In practice, regulators in a few states like Gujarat and Uttar Pradesh have set low retail tariffs based on declared State subsidies.

Subsidies are a more direct instrument to protect the poor. However, in many cases subsidies are set at levels that extend well beyond the poor. For example, in Tamil Nadu, all household consumers received 100 kWh/month of electricity free for FY2019, while Delhi's 400 kWh/month subsidy threshold is high enough that over 90% of household consumers get a subsidy at some point in the year (Tongia, 2017).

Cross-subsidies are meant to be a zero-sum game and there are rules that cap the cross-subsidy to ±20% above or below cost (benchmarked as the ACoS, also termed ACS in some documents). The original Electricity Act 2003 stated that

cross-subsidies as established by SERCs shall be "progressively reduced and eliminated" as per Section 61(g), Electricity Act 2003 (GoI, 2003), but this was subsequently amended with effect from June 15, 2007, to "progressively reduced". The National Tariff Policy subsequently notified the cross-subsidy limit to be ±20% of the ACoS.

The specifics from the Electricity Act 2003 are:

"Section 61 (Tariff Regulations).

The appropriate commission shall, subject to the provisions of this Act, specify the terms and conditions for the determination of tariff, and in doing so, shall be guided by the following, namely:

. . .

(g) that the tariff progressively reflects the cost of supply of electricity and also, reduces cross-subsidies in the manner specified by the appropriate commission;

. . .

(i) the National Electricity Policy and tariff policy:

. . .

Section 62 (Determination of Tariff)

3) The appropriate commission shall not, while determining the tariff under this Act, show undue preference to any consumer of electricity but may differentiate according to the consumer's load factor, power factor, voltage, total consumption of electricity during any specified period or the time at which the supply is required or the geographical position of any area, the nature of supply and the purpose for which the supply is required."

The Tariff Policy (2006) set an objective to attain a cost-reflective tariff with a cross-subsidy range of 80 - 120% of the ACoS by FY11 .

The specifics from the Government of India's revised Tariff Policy 2016 (2016) are:

8.3 Tariff design: Linkage of tariffs to cost of service

"….

2. For achieving the objective that the tariff progressively reflects the cost of supply of electricity, the Appropriate Commission would notify a roadmap such that tariffs are brought within ±20% of the average cost of supply. The road map would also have intermediate milestones, based on the approach of a gradual reduction in cross subsidy.

As we can see, the benchmark for cross-subsidies is the cost coverage in consumer tariffs from the ACoS, but there remains some ambiguity on what granularity of consumer tariffs needs to be considered. Current interpretations are at an ABR per consumer category. We revisit these issues (the use of averages) subsequently, as they add yet another possible layer of further cross-subsidy. For now (and unless stated otherwise), we focus only on the averages—both billing rates per consumer category and DisCom cost of supply.

Literature Review

While there are many publications that examine consumer prices, far fewer focus on the process, and even fewer take an all-India or aggregate view. Most literature has focused on the cost-revenues gap, with repeated calls including by the central government for "tariff rationalisation".

The PFC's annual *Report on Performance of State Utilities* gives detailed DisCom level analysis. It is based on values as reported to them by the DisComs. As it is *ex-post,* it is not a source of data for regulator-set retail tariffs. It is also based on accrual accounting (booked value accounting), which masks issues that cash accounting can reveal. A key statistic is the 'revenue per consumer' category, which is the revenue booked. However, PFC only lists consumer revenues as billed (or received), and thus excludes subsidies for each consumer category. Subsidies are listed as a separate line-item category of aggregate revenues to the DisCom.

A report by Council for Energy, Environment and Water (Aggarwal, Viswamohanan, Narayanaswamy, & Sharma, 2020) analysed the issue of cross-subsidies, but that is based on data from a recent edition of the PFC's state utililites performance report. The analysis inherits the lacuna from the data. By missing subsidy apportionments per category, we cannot get the true picture of regulator-set tariffs. Second, it is only based on *ex-post* data, and hence doesn't tell us the *ex-ante* story, which is key to studying the regulator-set tariff.

Mehta & Sarangi (2022) studied the cross-subsidisation policy by empirically investigating the levels of cross-subsidy based on a range of independent variables including reforms, rise of RE, political variables, and demographic/ legacy issues. They posited that excessive cross-subsidy would be a revenue risk for DisComs if Commercial and Industrial consumers start exiting DisCom supply (e.g., through Open Access or RE). They suggested an equitable penetration of renewable energy source for all categories of consumers. However, they didn't quantify per consumer category cross-subsidies, nor examine compliance with norms that limit cross-subsidies.

While not focused on cross-subsidies, a study by Prayas (Energy Group) (2019) compared subsidies both *ex-ante* (from Tariff Orders) and *ex-post* (from PFC Data), finding huge delays and gaps in payments of subsidies. They also found enormous discrepancies in reporting subsidy data. The study focused on six major states—Gujarat, Haryana, Punjab, Tamil Nadu, Uttar Pradesh, and Bihar—where subsidies were 10-30% of total revenues. The analysis is relevant because subsidies and cross-subsidies are deeply intertwined as we detail subsequently. Changes in cross-subsidies set by the regulator can directly impact the promised subsidy burden on the state.

The Forum of Regulators (FoR)—a collective body of all State Electricity Regulators under the aegis of the Central Electricity Regulatory Commission (CERC)—also has two reports examining DisCom pricing. The first, *Roadmap for Reduction in Cross-subsidy* (FoR, 2015), is directly relevant but limited in its coverage of DisComs and lacks *ex-ante* and *ex-post* comparisons. The second, *Analysis of Factors Impacting Retail Tariff and Measures to Address Them* (FoR, 2022) focuses on absolute cost structures, and not performance, and both reports are limited to few selected states. While these are useful studies, giving many insights, they cannot be used to give an all-India picture, more so given the known wide heterogeneity across India.

A recent report by the [Parliamentary] Standing Committee on Energy (2022) on Power Tariff Policy examined a range of topics on tariffs and DisCom health. Based on inputs from specific states, it was also limited to few states only. The report recommended setting cost-reflective tariffs and also adhering to the cross-subsidy limit as per the National Tariff Policy.

Study Methodology

Highlights

- The study is a first-of-its-kind financial analysis that aims to tease apart cash-basis financial gaps and their causes for DisComs. It is based on a compiled Tariff Order database that covers category-wise sales and revenue data for 60 DisComs that cover more than 90% of units sold in 2019.
- The bottom-up analysis incorporates three major methodological improvements over available studies:
    - It compares *ex-ante* Tariff Orders with *ex-post* performance to quantify any DisCom financial gap.
    - It disaggregates collection losses, a subset of AT&C losses, into non-payment of government subsidy and non-payment from consumers.
    - It adjusts the *ex-post* PFC booked values reported (accrual accounting) to cash accounting, along with an apportionment of subsidies.

This paper builds on literature by filling in the gaps between accounting methodologies and examining virtually all the DisComs in detail. As stated in the Introduction, we focus on cross-subsidies and overall financials both *ex-ante* and *ex-post*.

The first part of the analysis focuses on how tariffs are set *ex-ante* by the regulator. It follows a bottom-up approach compiling data at the consumer-category level (as defined in respective state tariff schedules). We use cost (ACoS) and per-category ABR as notified in Tariff Orders both *ex-ante* and *ex-post,* to determine both the overall financial gap (if any) and cross-subsidies between consumer categories.

Primarily due to data limitations but also due to inherent heterogeneity of slab (tier) levels that make more granular comparisons near impossible, we do not factor in intra-category (consumption slab level) heterogeneity for base calculations. Tariff Orders also have myriad sub-categories across states, e.g., some bifurcate rural versus urban homes. We simplify the numbers for comparison's sake by aggregating sub-categories into Residential (aka Domestic), Industrial, Commercial, Agricultural, and Others for both the *ex-ante* (planned) and *ex-post* (as-realised) analysis.

We focus on Tariff Orders per DisCom for FY19. This covers costs, revenues, and energy sales data compiled from Tariff Orders of various SERCs for 60 DisComs.[7] This represents more than 90% of electricity sales through utilities in India—we exclude a handful of private utilities (most of which are urban), but include Delhi's private utilities.

For the financials and cross-subsidy as-realised, i.e., the *ex-post* analysis, we rely on the PFC Report on Performance of Power Utilities. We

[7] Compilation of Tariff Orders across India is a heavily manual bottom-up exercise. Not only are these not aggregated, there are also wide variations in consumer categorisations; witness Table 2 that showed the enormous range of categories for BESCOM. We also relied on Tariff Petition data that often adds more data on consumer heterogeneity, especially at a slab (tier) level.

spot cross-check these for some DisComs against their audited Annual Reports. The PFC data are a good source for volumes of sales per category, given that True-Up data for some states for FY19 were not yet complete or at least publicly available in detail at the time of analysis.

Two of the main improvements to existing analyses are relatively straightforward.

First, we adjust *ex-post* PFC calculations to go from booked values as reported (accrual accounting) to cash accounting. This is especially important given a large fraction of AT&C losses are for failure of collection, but these are still booked as "revenues" under accrual accounting.

Second, we break down AT&C losses across its components. The AT&C losses are a hybrid measure only applicable at the DisCom level, and thus should not be confused with T&D (transmission and distribution) losses that most countries report. "Distribution losses" as reported in India under AT&C losses have two components—the loss of energy (kWh) and the loss of money (rupees).

The first step of AT&C calculations is *billing efficiency*, which measures how much energy is sold to consumers compared to how much the DisCom takes in at its periphery from generators (including transmission losses). Such distribution losses are due to both technical losses on the wire or transformer, and theft, and it's impossible to precisely segregate the two without a range of assumptions. The second step is *collection efficiency*, a measure of how much money the DisCom receives compared to what it billed.

Thus, theft is actually measured as a loss of energy, and not directly as a loss of money. Theft does have financial implications, because the DisCom now has to procure more power from generators to serve the same load. This loss exemplifies a subtle aspect of AT&C calculations. *The financial losses are based not on the absolute levels of billing efficiency or collection efficiency, but the performance compared to the normative targets set by the regulator.* Tariffs are set assuming and allowing a certain level of AT&C losses. Thus, if a DisCom has a target distribution network loss (aka billing inefficiency, or 1 minus billing efficiency) of 15%, and it achieved 16%, its billing losses *at a financial level* are only 1%, that too measured in kWh. The financial implications are based on needing to buy more power from generators to meet a given demand.

For our second methodological improvement, we also disaggregate collection losses between the two components of non-payment, something missing in most publications. Officially, collection efficiency compares billed or booked revenues per consumer or consumer category versus what was realised. Collection efficiency thus combines subsidy non-payment (by the state) and consumer non-payment (ostensibly the fault of the DisCom). If a subsidy isn't paid in full, that represents a cash loss to the DisCom, but if we apply accrual accounting, such unpaid subsidies would show as booked revenues and thus not show up as a loss.

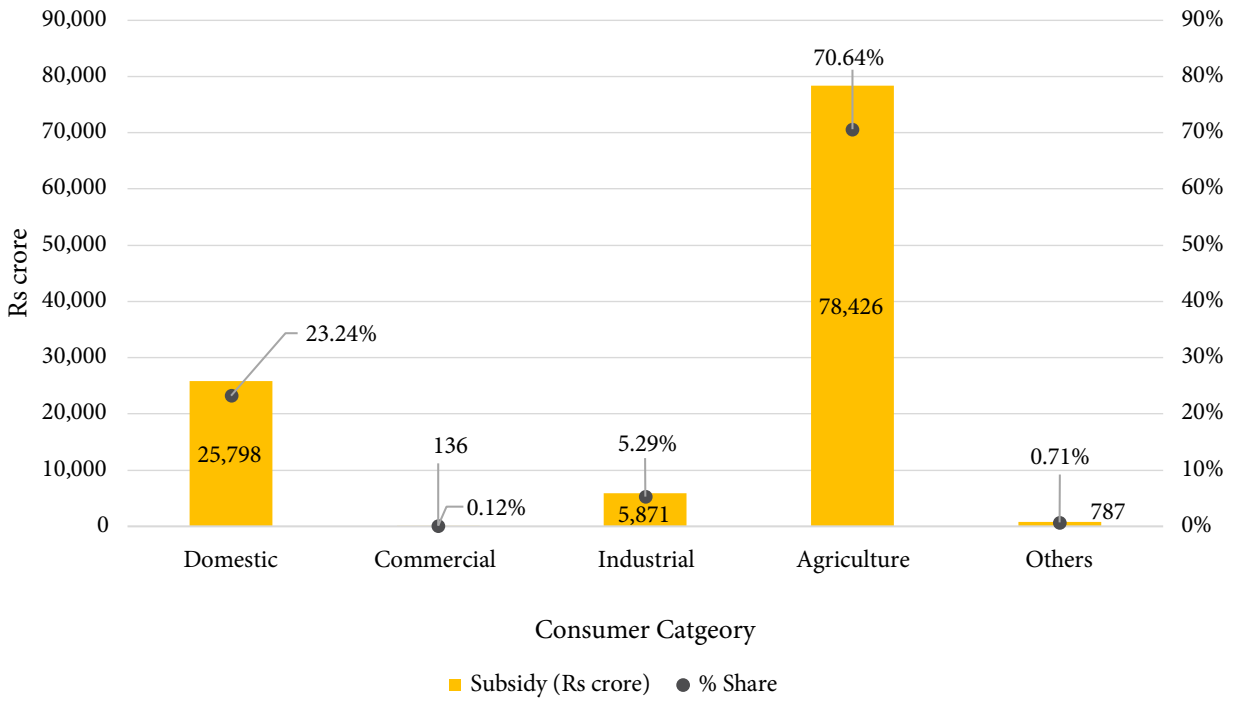
Such cash basis losses extend to the concept of "Regulatory Income". As mentioned before, Regulatory Income is when a regulator recognises a certain level of costs, but doesn't issue a commensurate tariff, ostensibly to avoid a tariff rise shock to the consumers. Such missing revenues are booked as Regulatory Income for operations, and accumulate in the balance sheet as Regulatory Assets. Regulatory Assets are only liquidated by future rises in tariff. In theory, the higher level regulator, the Appellate Tribunal for Electricity (APTEL, that sits above

state regulators), has asked SERCs to stop creating Regulatory Assets (Appellate Tribunal for Electricity, 2011), but not all SERCs have complied. In addition, the expectation is that Regulatory Assets should be cleaned up through tariff increases in a "reasonable" timeframe.

The most complex and third adjustment we performed to readily available data was to apportion subsidies to different consumer groups. *Ex-ante*, regulators mostly set tariffs per consumer type agnostic of state subsidies, but *ex-post*, PFC data only show revenues as billed (and booked) per consumer category. Any subsidy for a particular class of consumer, which lowers what they are expected to pay, is not listed directly, and only the DisCom total subsidy (both booked and received) is listed. This is a limitation of prior studies such as by Aggarwal *et al.* (2020) , which calculate cross-subsidies without correcting for subsidies—critical since cross-subsidies are mostly set up by the regulator before subsidies.

We use Tariff Order data and other public data on subsidies to estimate the apportionment of the subsidy as booked (billed to the state) *ex-ante*. It is only in the *ex-post* analysis we examine whether all the booked subsidy was received or not. The Forum of Regulators (FoR) study on cross-subsidies mentioned previously, does consider regulator-set tariffs *ex-ante*, which avoids issues of subsidies, but they limit the analysis to only a few states.

Figure 2: All-India Tariff Subsidy from State Governments per Consumer Category (FY19)



Source: Authors' compilation and estimation from different reports, PFC database, Tariff Orders, and petitions.

Note: The subsidy bifurcation is based on the best available information in the public domain and are Author estimates. The total subsidy estimated is ~Rs 1.11 lakh crore based on the ex-post consumer mix of sales. We can see the majority of subsidies went for agricultural users.

About 90% of subsidies, which total about one-seventh of the system costs, go to Domestic and Agricultural consumers. Figure 2 shows our aggregated all-India estimate of subsidies based on per-DisCom allocation by the authors. Almost 71% went to agricultural users, and 23% to households, varying heavily by state. We examine subsidies in more detail later, but it's worth noting that for these two categories, subsidies are a high fraction of expected total revenues. Of course, the exact quantum of subsidies will vary *ex-post*. This is not just due to *ex-post* changes in volumes of units sold to a given type of consumer, but also the mechanism for subsidies. Some subsidies can be flat rate per unit, while others are set as a share of total costs.

There are a few other small nuances of methodology or corrections worth mentioning. In the PFC report, revenue from consumer sales excludes some share of fixed charges and recovery from theft. These are accounted for, but under a different heading. Examining individual Tariff Orders, there is no consistency in how they itemise or report such costs, and Tariff Orders obviously cannot predict theft-recovery penalties in advance. Hence, we keep such revenues separate from consumer revenues as well.

Box 1: Details of Data and Methodology

The Ministry of Power has repeatedly noted a lack of consistency in Tariff Order data and lack of timely processes like issuance of Tariff Orders. Such data limitations forced us to make a range of minor assumptions or tweaks to the data. For example, for Tamil Nadu, we used Tariff Order data from FY18 as FY19 data were not available at the time of analysis.[8] For Jharkhand, Haryana and Odisha, some numbers are estimated as the aggregate revenue is not available from the Tariff Order. In such cases, the total revenue is calculated based on the projected volume and the listed ABR per consumer type. In some cases, the ABR used was taken from the cross-subsidy surcharge calculation section of the Tariff Order or tariff petition. In the case of Gujarat, fuel and power purchase price adjustment (FPPPA)[9] charges were listed separately in the revenue sources, but category-wise revenue at revised prices was not given. Thus, for Gujarat, ABR is calculated using revenues based on the FY18 Tariff structure, aggregated with revenue from FPPPA charges listed for FY19, apportioned by the weighted consumer-category energy sales.

[8] Tamil Nadu is relatively unique as it has an integrated Generation and Distribution company, unlike most states where distribution is separated. We have attempted to account for such differentials to the best of our abilities.

[9] Fuel and power purchase price adjustment (FPPPA) or Fuel Adjustment Charge (FAC) is a regulatory tool that is levied on consumers on a per unit (kWh) basis to cover the increase in actual fuel (variable) cost. Ideally, these charges are revised quarterly by the Regulator. These are floating, because in most DisCom PPA's, fuel costs are passthrough to consumers.

Findings on *Ex-Ante* Cross-subsidies and Financials

Highlights

- *Ex-ante* FY2019 Tariff Orders almost always set tariffs sufficient to cover projected costs.
- While there is heterogeneity across DisComs, on average commercial users pay the most, followed by Industrial, while most residential users underpay, with agricultural users enjoying the lowest tariffs.
- More than 50% of the energy consumed—at a consumer category level—had tariffs in violation of the limit of ±20% cross-subsidy compared to the average cost of supply. The violations in tariff were disproportionately in the domestic and agricultural sectors.
- If we cap the consumer ABR to within ±20% cross-subsidy, on average DisComs would face a modest decrease in revenues of 1.4% compared to the *ex-ante* ACoS. However, to comply with the cross-subsidy limit would mean raising the tariff for underpayers by 30%.

There is Cross-subsidy Heterogeneity Across DisComs, with some Trends

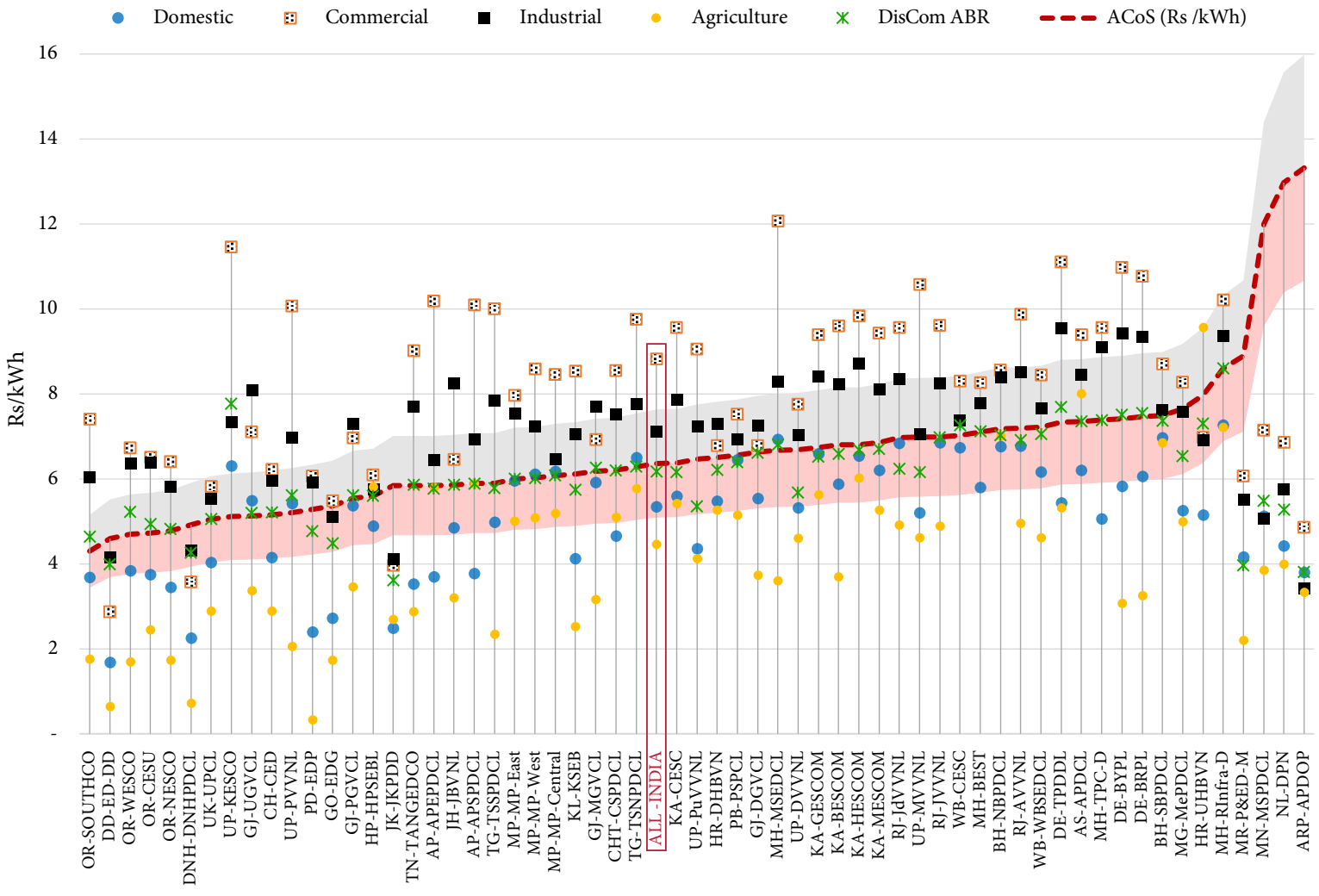
Examining almost all the DisComs across India, we find that there is wide heterogeneity in cross-subsidy levels across India, showing no clear pattern for predicting how much cross-subsidy a DisCom will have, either based on DisCom costs or by per consumer sales volume (a proxy for consumer wealth). There are disparities at every level of tariff slabs, and even within a state with multiple DisComs.

Figure 3 shows the DisCom-wise FY19 *ex-ante* ACoS, the benchmark for cross-subsidies and the ABR; the ABR is both overall for the DisCom as well as per-category.

Importantly, we see that most DisComs' overall ABRs are targeted very near the ACoS and that the *ex-ante* all-India ACoS-ABR gap was only 2%, based on revenue from sales of power. In addition to such revenues, most DisComs have expected revenue from other operations, like network access charges for wheeling power that lower the final *ex-ante* all-India gap to less than 1%. The real *ex-ante* gap is even lower than this because of subsidy recognised by a few regulators when setting tariffs, and is actually a small surplus on average.

At a category-level, the general trend (varying slightly by DisCom) is that the tariffs from highest to lowest are Commercial, Industrial, Residential (i.e., Domestic), and Agricultural. The "Other" category is not shown, as it varies based on its underlying components and is small in volume. It's a catch-all that inherently has both overpayers and underpayers. For example, public utility services like city lighting or water supply are undercharged, while transportation (including Railways) are overcharged (but the latter's consumption volume is falling, in part because the Railways are setting up or contracting their own renewable energy supply).

Figure 3: DisCom-wise *Ex-ante* ACoS and ABR (FY19) with Sector-wise Tariffs



Source: Authors' compilation and estimations from SERCs and Tariff Orders.

Note: The DisCom nomenclature is a combination of state names followed by DisCom, e.g., DE-BYPL represents [State = Delhi] and [DisCom = BYPL]. See Appendices for state and DisCom abbreviations.

The grey and pink lines are plus and minus 20% from the respective DisCom ACoS.

Many consumer categories violate the ±20% tariff deviation limit (shown as the grey (+20%) and pink (-20%) bands in Figure 3), reflecting very high levels of cross-subsidy. It's worth reiterating that these tariffs are set by the regulators, and consumers may pay less based on subsidies a state may choose to offer. For instance, farmers in many states pay no or very low fixed electricity charges. It is a separate policy discussion as to the "right" level of subsidies.

Even ACoS shows wide heterogeneity. States like Uttar Pradesh (UP), Delhi, Rajasthan, Maharashtra, Bihar, West Bengal, and Karnataka have significantly higher ACoS than the all-India average. These states represent 41% of total electricity sales. Higher ACoS could also be a potential reason for their charging a high tariff from commercial and industrial consumers. In the North-East, DisComs have a very high ACoS, in the range of Rs 8-14/kWh, often due to geographical and developmental limitations. Full recovery of such a high ACoS from residential consumers would lead to a very high billing rate, so cross-subsidies might be a chosen instrument to minimise the burden on households. However, as the figure shows, there is no clear trend of high ACoS translating to high cross-subsidies. This figure only shows prices, and not volume, so some of the states with high cross-subsidies at a price (rate) level may have less rupees being cross-subsidised, than other states.

National Aggregation and Spread of Cross-subsidy in Financial and Energy Terms

If we add volumes of sales per consumer category, we can calculate an aggregate picture of *ex-ante* cross-subsidies from the FY19 Tariff Orders; Figure 3 only showed the per unit rates for each consumer category or averaged across the DisCom.

Figure 4 shows the all-India aggregate split of consumers based on level of cross-subsidy charged across four buckets:

1. Paying beyond 120% of ACoS
2. Paying 100%-120% of ACoS
3. Paying 80%-100% of ACoS
4. Paying beyond 80% of ACoS

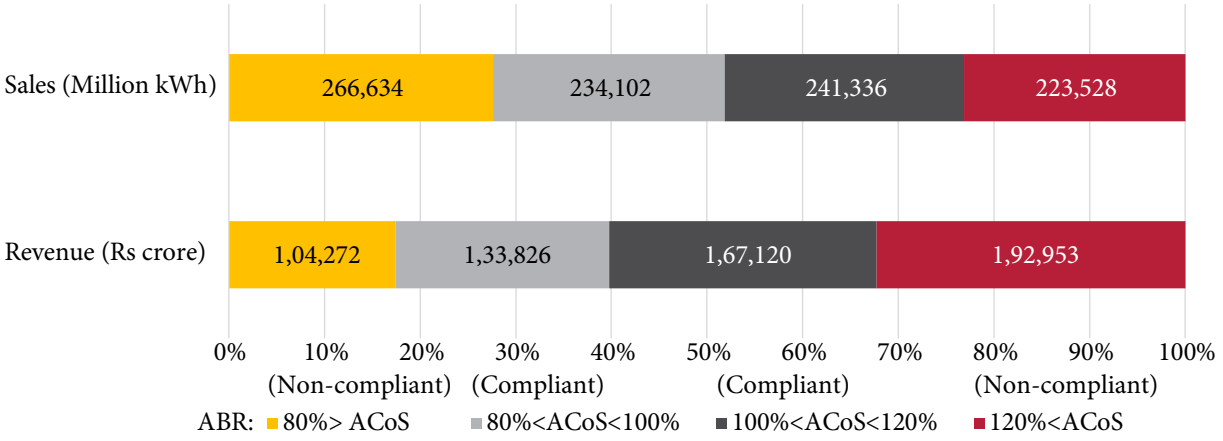
Compliant within ±20% of ACoS

On an energy basis, over half the units sold in FY19 had approved tariffs that violated the cross-subsidy limit of ±20% compared to average costs (ACoS) (yellow and red buckets); 28% of the energy sold had an ABR below 80% of ACoS, and 23% of energy sold had an ABR above 120% of ACoS. In revenue terms, this share of violations is 17% and 32%, respectively. State- and DisCom-level bucketing shows some variation but is mostly similar to the national picture.

Proper tariff setting requires full cost coverage, and regulators, for the most part, comply when setting Tariff Orders *ex-ante*. All cross-subsidies are close to a zero-sum-game. If we add in other planned revenues (like network access charges to third parties) to the revenue from sale of power, we find total *ex-ante* revenues equal or roughly equal the total *ex-ante* costs as notified by the regulator (for the BESCOM example in Table 1 (costs) and Table 2 (tariffs to give revenues), they matched exactly).

Figure 5 breaks down the all-India cross-subsidy by consumer category for FY19.

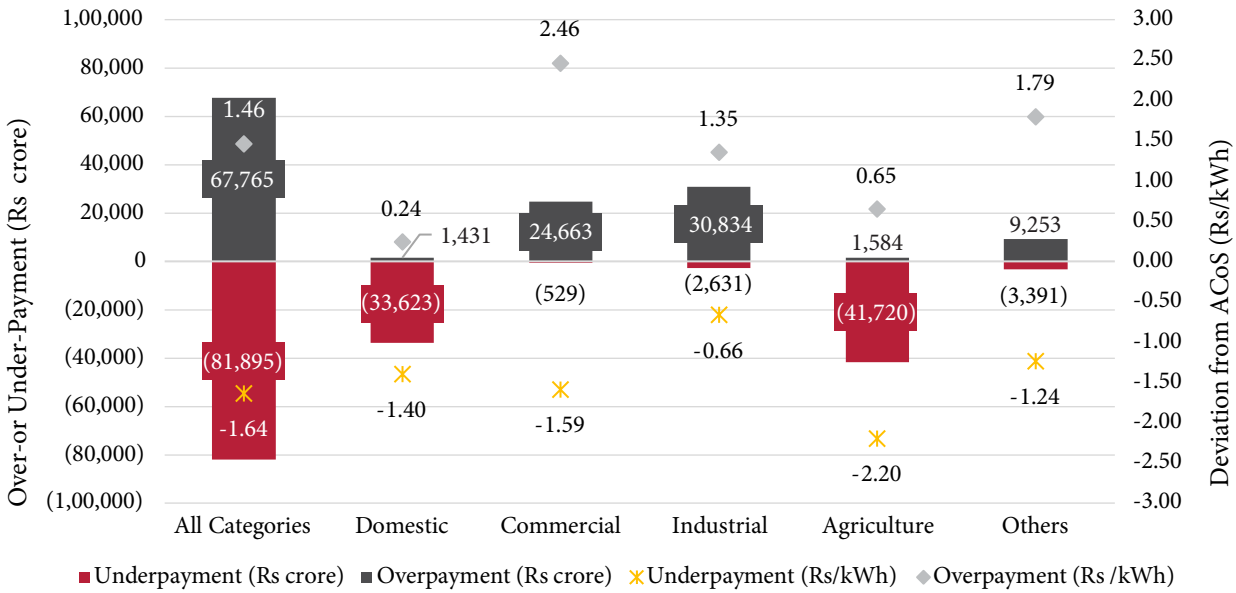
Figure 4: Regulator-set Sales and Revenues by ACoS Coverage Range (in %) (FY19)



Source: Authors' calculation based on tariff order data.

Note: These calculations are the aggregation of granular consumer tariffs from Tariff Orders, which may segregate small vs. bulk industrial consumers.

Figure 5: Consumer Category-wise Cross-subsidy (FY19 Tariff Orders)



Source: Author analysis.

Note: The overpayment and underpayment charges per unit are for those units that are overpriced versus underpriced, spanning both in-compliance and out-of-compliance tariffs based on the ±20% limit of cross-subsidies. For instance, for Industrial, if you overpay, it is by Rs 1.35/kWh on average, while any underpayment is only Rs 0.66/kWh on average. However, given that overpayment and underpayment volumes are not symmetric, the aggregate revenue implication is heavily skewed (much more overpayment than underpayment in this category).

Underlying calculations per consumer category segregate consumer sub-categories, e.g., small versus bulk industrial consumers, who have different tariffs.

The aggregate across all categories shows a modest underpayment compared to overpayment, but if we add in the Rs 8,900 crore from the few states (like UP) where regulators underset prices taking cognisance of announced subsidies by the state government, then overpayment and underpayment are very close to equal. For reference, the total *ex-ante* costs are Rs 6.01 lakh crore from these Tariff Orders.

At a category level, we see the expected bucketing—who overpays versus underpays. The average underpayment by Agricultural consumers is Rs 2.20/kWh, while Domestic users underpay on average by Rs 1.40/kWh. Coming to overpaying categories, on average, Commercial users overpay by Rs 2.46/kWh and Industrial users overpay by Rs 1.35/kWh. Notice that some DisComs have underpayment by Industrial users and overpayment by Agricultural users, but not only are these rare, the levels at which this occurs is also small.

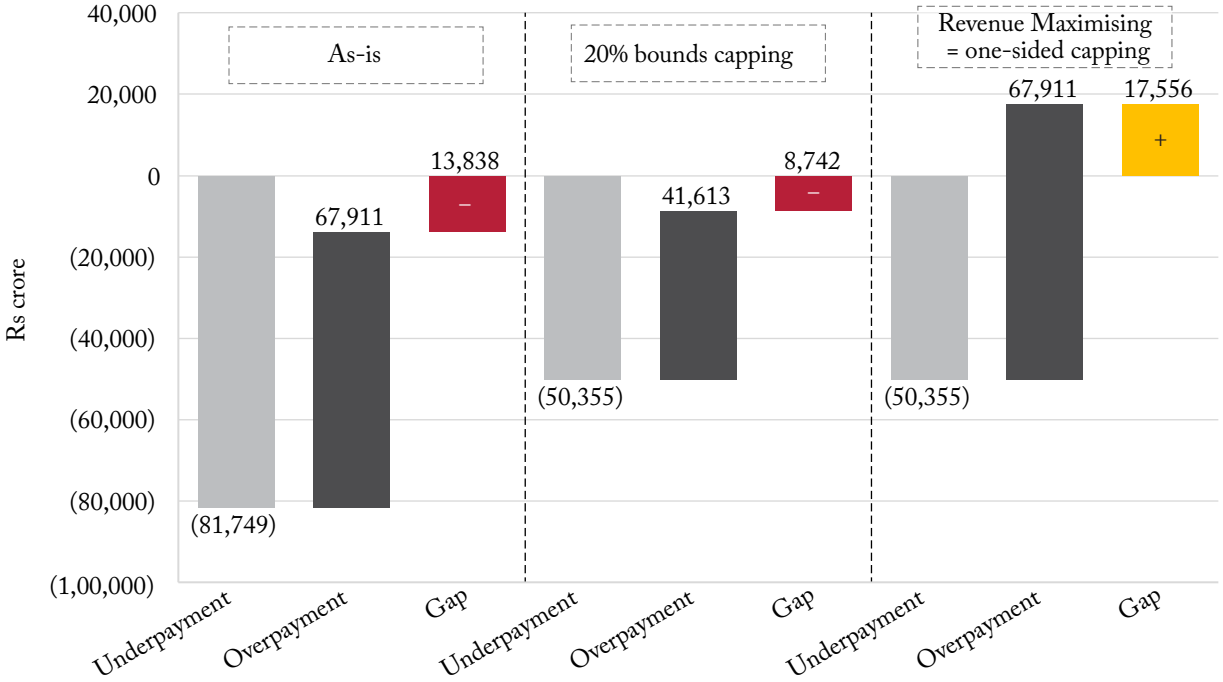
Two details are worth mentioning. First, these are only the cross-subsidies, the greatest beneficiary of which are Agricultural users. As we examine subsequently, they also benefit enormously from explicit subsidies paid by the state, further lowering what end-users have to pay. Second, these are category-level aggregates, which may or may not apply to all sub-categories within the headings shown. We know (and also detail subsequently) there are huge tariff ranges within many categories based on both sub-categories as well as pricing slabs (tiers). However, for some categories, almost all consumers conform to the trend of, say, overpayment. For example, there are few cases of commercial users paying less than ACoS or even paying significantly differently from the category ABR. Thus, even a small telephone booth, a photocopy centre, or a chai-shop, etc., pays almost as much as a major shopping mall, at least in terms of energy consumption charges per unit. Of course, this assumes they take a formal commercial connection.

DisCom Implications of Complying with the ±20% Cross-subsidy Limits versus ACoS

What would compliance look like compared to the FY19 scenario of tariffs? For those consumer groups that are paying below 80% of ACoS, their tariff would need to rise, but for those paying above 120% of ACoS would see tariffs fall, but at a lower relative rate (given their higher base). Because of volume skews for overpaying versus underpaying groups, in many cases compliance shifts on one side need a disproportionate rise on the other side (as shown in Figure 5).

Figure 6 shows what happens to electricity tariffs on an aggregate all-India basis under different scenarios of compliance with cross-subsidy norms. Present *ex-ante* tariffs have a gap of Rs 13,838 crore, but DisComs also have other income, like network access or wheeling charges recognised by regulators of a few thousand crore rupees. In addition, tariffs are set low by a few regulators who take cognisance of announced subsidies (Rs 8,900 crore in the case of UP). Thus, the net *ex-ante* finances for DisComs actually start with a small surplus, but our focus here is only on consumer tariffs. As the middle of Figure 6 shows, compliance per DisCom at a category level (capping cross-subsidies to ±20% of ACoS) would reduce both overpayment and underpayment, with aggregate revenue changes upwards that lower the gross gap to Rs 8,742 crores. As a thought exercise, we also compare what happens if we only raise tariffs that are too low, but keep out-of-compliance over-paying tariffs as-is. In such a revenue-maximising scenario, the *ex-ante* gap turns into a surplus.

Figure 6: Estimated Financial Gap in Different Compliance Scenarios (FY19)



Source: Authors' analysis.

Note: The revenue maximising scenario is where underpayers find a rise in tariff but overpayers keep tariffs as-is. If the revenue maximise by only raising tariffs that are too low, then the gap turns into a surplus.

At first glance, it would be illogical to have a surplus as shown due to one-sided capping. However, as we shall see in the next section on *ex-post* financials, there is actually a substantial cost-revenue gap for DisComs, one that isn't captured properly in *ex-ante* Tariff Orders, so we have far less headroom to lower tariffs for over-payers.

We must also not ignore DisCom level heterogeneity. In the total sample of 60 DisComs, compliance (20% capping) means 33 DisComs will be net positive in revenues, 24 DisComs will see a decrease in revenues, while three are already compliant and thus have no change in revenues. This asymmetry is disproportional in selected categories with either high volumes or disproportionally higher (or lower) tariffs. For example, Commercial and Industrial consumers in Delhi and Industrial consumers in Madhya Pradesh are disproportionately burdened with an ABR of more than 120% to their ACoS. The reduction in their tariff to meet the +20% cross-subsidy limit will decrease the utilities' net revenues in Delhi by Rs 1,333 crore, even after accounting for any increases from underpaying consumers, which are limited.

Consumer Implications of Complying with the ±20% Cross-subsidy Limits versus ACoS

The flip side of what happens to DisComs, shown above, is what happens to consumers.

Table 4 converts the total change from compliance into per unit (per kWh) implications for consumers, split by compliance buckets. These are the *ex-ante* tariffs from the Tariff Orders.

Table 4: Average Tariff Change with ±20% of ACoS Capping of Cross-subsidies (FY19)

	Compliant electricity (within the capping limits)		Electricity violating the ±20% caps	
	Underpaying within limits	Overpaying within limits	Underpaying beyond the limits	Overpaying beyond the limits
Energy sales (Million kWh)	234,102	241,336	266,634	223,528
Revenue (Rs crore)	1,33,926	1,67,120	1,04,272	1,92,953
Energy sales (%)	24%	25%	28%	23%
Revenue (%)	22%	28%	17%	32%
ABR (Rs/kWh)	5.72	6.92	3.91	8.63
Average change in tariff (Rs/kWh) (Increase [+]/Decrease [–])				
±20% Capping			1.18	-1.17
Average change in tariff (in %) (Increase [+]/ Decrease [–])				
±20% Capping			30%	-14%

Source: Authors' analysis from Tariff Orders, with sub-category level pricing (e.g., separating small vs. bulk industrial consumers).

Note: The average all-India Average Billing Rate (ABR) in FY19 was 6.14 Rs/kWh.

For non-compliant under-payers, the required rise is exceptionally steep. For the underpaying non-compliant electricity units sold, which were 28% of the total sales, their average required tariff rise would be 30% (see Table 15 in Appendix B2: DisCom-wise Details for Tariff Hikes). In comparison, as per PFC data, in the last five years through FY19 the all-India ABR growth rate was only 5%. For very high payers (above 120% of ACoS), they would find a reduction of 14% on average, giving an equal (within rounding error) per unit offset of Rs 1.17/kWh, matching the rise from highly underpayers.

This is the all-India aggregate—there is far more variation across DisComs and by consumer category, as shown in Appendix A. In some cases, tariffs would need to more than double! Even a 10-20% rise in tariffs becomes challenging, so such a steep rise, that too for the lower paying categories, is not easy to implement, even if phased out over several years.

Phasing out worked for diesel price reforms, which clearly demonstrated the efficacy of price increases with limited economic disruption (Clarke, 2015). However, that process benefited from a fall in global crude oil prices, which created a cushion to raise end-user prices. There doesn't seem to be any equivalent cushion for electricity. Even cheap solar power for power procurement doesn't seem like it will last, in part due to rising supplier costs post-COVID and Russia's invasion of Ukraine, but also because after a point we can't add solar alone—we would need a battery as well, raising costs.

A cross-subsidy limit compliant tariff structure will improve the cash flow for DisComs. Historically, differential tariffs in the name of cheap power for the poor went hand-in-hand with inequity in power supply (Harish & Tongia, 2014), especially with rural versus urban supply. Rural consumers often have limited hours or fixed hours of supply (in the case of agriculture consumers), which sometimes went hand-in-hand with a lower tariff rate. For example, in Karnataka there is explicitly a lower tariff for rural households for the same volume (slab) of consumption as urban households, but rural consumption is lower than urban across India, so the total monthly household bills are much lower in rural areas. Load-shedding, which is worse in rural areas, is a poor way to provide cheaper power, and Harish and Tongia (2014) found that load-shedding differentials offset any tariff-based welfare transfers for rural areas, at least in their study of Karnataka. On the other hand, making DisComs bear losses also shouldn't be the preferred instrument for "affordable power" for the poor.

Findings on *Ex-Post* Cross-subsidies and Financials

Highlights

- There is an enormous shift in financials *ex-post* where DisComs go from almost no gap *ex-ante* between costs and revenues to a cash-basis gross gap of 1.64 Rs/kWh. The average net gap reduces to 1.01 Rs/kWh only because of "Grants and Other Income" that is not part of regulatory tariff-setting.
- There is an enormous skew in the shift, indicating this isn't just a random error in making a priori assumptions when setting tariffs. Costs increase by 19% on average and almost across the board, while revenues decline slightly on average.
- Underlying causes for the shifts vary by DisCom, spanning changes in sale mix, sale volume, power procurement costs, other costs, etc. The single largest component is change in power procurement costs.
- Contrary to conventional wisdom, DisCom performance lapses like excess distribution losses or non-collection from consumers are only about a quarter of the source of the financial gap.

Tariff Orders are inherently based on a wide range of assumptions, so it is inevitable for *ex-post* numbers to differ. The key questions are how and why do they differ?

One key aspect of changes is volumes sold. This affects both costs and revenues. Procuring more (or less) power from generators is likely to impact power procurement costs non-linearly. Not only will changes in demand affect the volumes procured, costs will also change based on which generator ultimately sold how much power.

If there is slack supply with an existing generator under a traditional PPA, it would supply such power at incremental or fuel costs, which would be lower than the DisCom's Average Power Procurement Cost (APPC); PPAs covered 72% of sales in India as of March, 2018 (Kumar, Mishra, & Banerjee, 2022), and CERC data for recent years indicate a higher share for PPAs. For most thermal (coal) power, which dominates sales, fixed costs under a PPA are independent of offtake, paid for simply having availability at a specified level, and so the marginal cost of more supply is simply the fuel cost, which is lower than the total cost. On the other hand, if such suppliers don't have additional output available, something that depends heavily on the time of day of demand, then DisComs often resort to spot market or third-party purchases that can be more expensive than the APPC.[10]

Changes in volume can impact revenues more than costs. Even if the *total* power required in any given time period doesn't change, because of differential retail pricing (cross-subsidies),

[10] Examining procurement costs in details shows no easily visible trend, but in some cases, even with a fall in volume, absolute (and not per unit) costs rose. This needs further study.

changes in consumer mix will have a non-linear impact on revenues. Changes in volumes of sales to different categories can be a double whammy because different consumer types need power at different times, impacting procurement (e.g., industry needs power mid-day, which coincides with solar, but residential demand is heaviest mornings and evenings).

Costs can and do change even due to non-volume-linked factors, such as if a DisCom may have to find different suppliers, or have other operational costs higher (or lower) than planned. Other costs include financial charges, physical costs of operations, and employee costs.

Table 5 shows the *ex-ante* and *ex-post* volumes sold along with the average per unit (per kWh) revenue and cost. The ACoS-ABR gap at the time of tariff approval was just Rs 0.06 /kWh, or slightly surplus if we add in the subsidy recognised by regulators in Uttar Pradesh at the time of setting tariffs and revenue from other operations such as cross-subsidy surcharges (CSS), wheeling charges, etc. However, *ex-post* the cost-minus-revenues gap in FY19 became Rs 1.64/kWh. This includes revenues from operations and also tariff subsidies. These are all calculated on the basis of units or energy *sold*, not input energy at the distribution incoming periphery.[11] These are the gross losses or gap, before any grants or other income that lowers the net financial gap (cash-basis), which are detailed in the subsequent section. Such grants or other income were not part of the regulator's tariff setting, and hence should be separated from *ex-ante* versus *ex-post* revenue calculations.

Indian average prices are low compared to many countries, but one differentiator is taxation rates, which can be very high in places like Europe. Taxes are not part of the numbers in this analysis, since we focus on regulator-set retail prices. However, as we subsequently discuss, the per consumer category prices show wide divergence from many other countries.

Table 5 shows a much greater shift in costs (ACoS) than in revenues per unit (ABR). While this paper focuses on FY19 in detail (because this is the last year before COVID's effects, and also because audited data for the year were available at the time of analysis), examining just the change in cost structure *ex-ante* to *ex-post*, we find there was also a consistent upward shift in costs in FY20 (10%) and FY21 (9%), based on a sample of 39 DisComs. We examine the causes of cost changes subsequently. The deviation in volume of units sold is not very large in aggregate, and even per category volume deviations are modest (though state-level variations are higher). The greatest change in ABR was in the 'Others' category, but the volume of sales for this category is relatively low overall.[12]

Ex-Post Data also Show Significant Support (like Grants) and Extra Income

Before we dig into the causes of the changes in costs, we need to understand the final financial position of DisComs. Most of the analysis thus far has focused on DisCom operations, overwhelmingly based on sales of power.

[11] Calculating the cost vs. revenue gap based on energy sold is superior compared to per unit input energy, as it reflects what end-user tariffs are. Power Finance Corporation calculates the gap in terms of input energy, and hence: (i) their calculated shortfall is lower (gross input energy is more than net sold; and (ii) there is a larger denominator in PFC's methodology for per unit losses.

[12] One reason the agricultural volume doesn't change so much from *ex-ante* to *ex-post* might be because most agricultural units sold are unmetered and thus assumption-driven, e.g., based on reported hours of supply and nameplate horsepower capacity of the pump set. Unfortunately, this reality also lends itself to reverse engineering or manipulation.

Table 5: All-India Projected versus Actual Volume, Revenue, and Cost (FY19)

Consumer categories	Projected (*ex-ante*)		Actual (*ex-post*)	
	Sales (Million units or kWh) [share in total]	ABR (Rs/kWh)	Sales (Million units or kWh) [share in total]	ABR (Rs/kWh)
Domestic	266,069 [31%]	5.26	244,767 [28%]	5.51
Commercial	87,002 [10%]	8.92	77,197 [9%]	9.40
Industrial	225,390 [27%]	7.45	252,098 [29%]	7.70
Agriculture	202,616 [24%]	4.33	202,763 [23%]	4.23
Others	69,917 [8%]	7.10	90,081 [11%]	5.73
TOTAL ALL-INDIA (Revenue from sale of power)	850,993	6.14	866,906	6.21
ABR based on regulated retail tariff (Rs/kWh)		6.14		6.21
Subsidy accounted by regulator while tariff setting (Rs/kWh)		0.10		-
Adjusted ABR – booked basis (Rs/kWh)		6.24		6.21
All-India realised ABR (from sale of power) (Rs/kWh)		6.24		5.77
Other operating revenue (Rs/kWh)		0.07		0.03
Total realised ABR (Rs/kWh) (All-India realised consumer ABR + Other operating revenue)		6.31		5.80
ACoS (Rs/kWh)		6.27		7.44
Gross gap (Rs/kWh) (-ve sign means surplus revenue)		**–0.04**		**1.64**

Source: The SERC's respective Tariff Orders and PFC's annual Report on Utilities (multiple years).

Note: The above comparison is based on 48 DisComs selected based on the closely similar dataset availability for estimated and actual numbers. This is representative of all of India, and covers about 85% of the sales in the country.

The 'Others' consumer category has a traction load share of 9% out of the total of 11% base.

Ex-post data show that most DisComs benefit from revenues under the heading "Other Income and Grants" that was not planned by regulators. This includes a range of sub-categories, not all of which are line-itemed or listed consistently across DisComs. Even operating grants (distinct from capital grants) are split in to "UDAY (scheme) Grants" and "Other Grants".

"Other Income" includes penalties and some fixed charges upon consumers. Ideally, other income should be separated and put into regular DisCom income, but the share is small. Regulators cannot plan for most of these sources of revenues. Table 6 shows the impact of the other revenue and grants that reduce the gap from Rs 1.64/kWh to Rs 1.01/kWh.

Table 6: Financial Gap (FY19) After Factoring in Other Income and Grants

	Projected (*ex-ante*)	**Actual (*ex-post*)**
All-India	**ABR (Rs/kWh)**	**ABR (Rs/kWh)**
Costs-minus-revenues gross gap from operations based on Regulatory Process (Rs/kWh) (-ve sign means surplus revenue)	**-0.04**	**1.64**
Actual gap adjustments (less):		
Revenue Grant under UDAY (Rs/kWh)		0.24
Other Income and Revenue Grants (Rs/kWh)		0.39
Final Gap (Rs/kWh) (-ve sign mean surplus revenue)	**-0.04**	**1.01**

Source: Authors' estimation based on SERCs' respective tariff orders and the PFC report on utilities (FY19).

Note: The above comparison is based on 48 DisComs selected based on the closely similar dataset availability for an estimate and actual numbers. This is representative of all of India, and covers about 85% of the sales in the country.

This unplanned income does lower the financial gap for DisComs, but tariffs were set without relying on these. Thus, if we consider the *ex-ante* to *ex-post* gap, it was 1.64 Rs/kWh. More importantly, it's not clear how much or for how long such additional revenue will continue in the future. The UDAY scheme is over. While another scheme may be in force, it's inappropriate to have a regulatory tariff set that relies on these upfront.

Not shown in the table is the change in cash-basis revenues due to the creation of Regulatory Assets, through what is termed Regulatory Income on an annual operating basis. This is because it doesn't affect the total gap, but becomes an instrument for parking the gap in the Balance Sheet to be recovered in the future.[13] It is a small subset of the Final Gap shown, and for these 48 utilities was only a few paise/kWh.

[13] Regulatory Income for a given year's operations is not the part of *ex-ante* revenue structure. As per authors' observations of FY19 Tariff Orders, it appears in *ex-post* reconciliation (True-Up). It is included in Profit & Loss statements as per PFC annual utility performance report, and is thus part of the Rs 1.01/kWh gap shown in Table 6. Even if it were notified *ex-ante*, Regulatory Income reflects insufficient tariffs compared to costs.

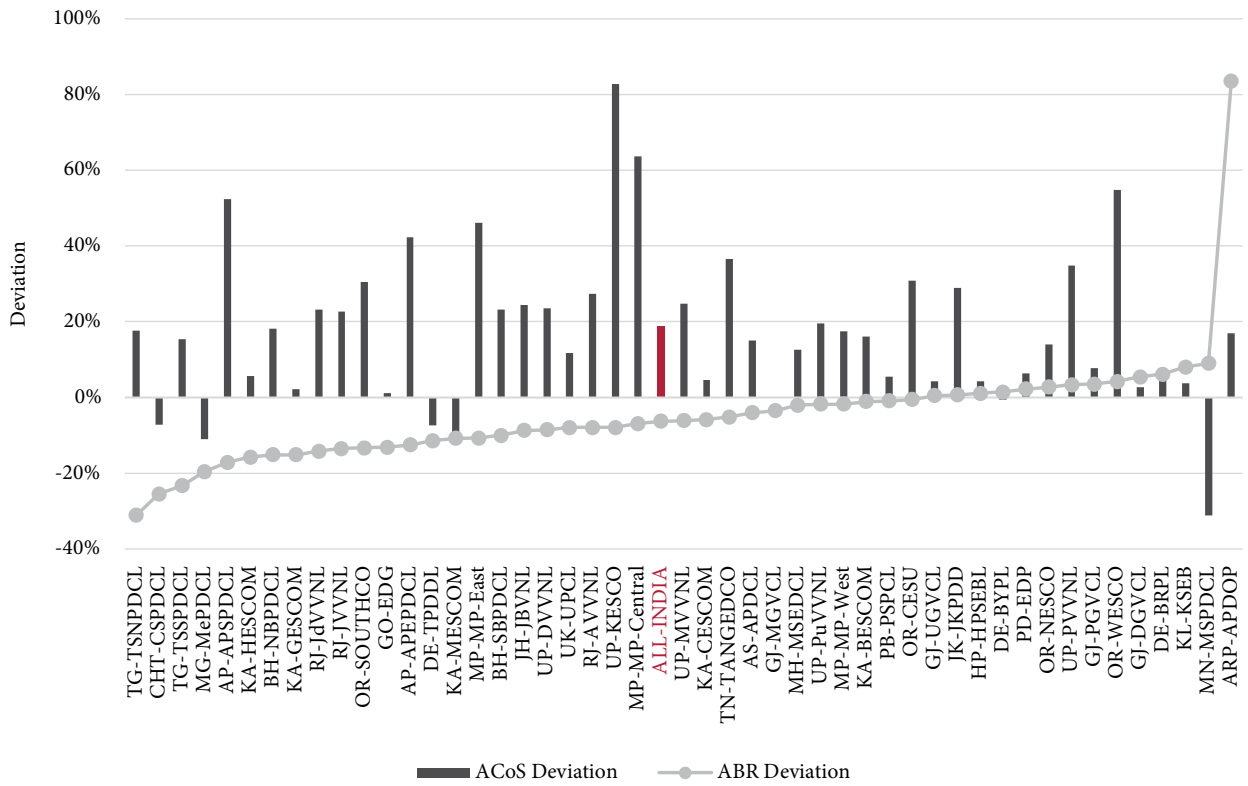
DisCom-wise ACoS and ABR Change from *Ex-ante* to *Ex-post*

Table 5 showed how costs and revenues changed between *ex-ante* and *ex-post*. The national aggregate shows a huge 19% average jump in costs, but the picture is even more stark when we consider DisCom heterogeneity (Figure 7). We see that not only is the deviation much higher for costs, it is higher across almost all the DisComs.

In contrast, while the national ABR fell somewhat, almost a third of DisComs actually had an *ex-post* ABR increase compared to *ex-ante*, and even the ones that saw a fall in average billing (which raises the financial gap), the fall was much more modest.

We know that *ex-ante* has assumptions, but if these were truly neutral assumptions, then there should be nearly symmetric deviations *ex-post*. The fact that there is such a one-sided increase in costs suggests it isn't just a random error that would be inevitable when making assumptions.

Figure 7: DisCom-wise Cost and Revenue Deviation between *Ex-ante* (planned) and *Ex-post* (as-realised)



Source: The SERCs' Tariff Orders (ex-ante) and PFC report data (ex-post, with author corrections for subsidies).

Note: The above comparison is based on 48 DisComs selected based on the closely similar dataset availability for ex-ante (regulator notified) and ex-post (actual realised) financials.

Actual ABR used for these figures are calculated on the basis of revenue realised.

Breaking down the Causes of Deviations Between Planned (*Ex-ante*) and Realised (*Ex-post*) Financials – Costs and Revenues

When breaking down the cause of shifts in revenues and costs, it is important to split different factors for the deviation from the *ex-ante* targets to isolate regulatory issues in tariff-setting versus DisCom non-performance deviations.

Costs include PPCs and Other Costs (Other Costs span financial costs, employee costs, and operating costs). Costs also include AT&C losses due to falls in billing efficiency compared to regulator-set benchmarks, which means the DisCom must procure more power than planned. Other aspects of failing to meet AT&C targets impact revenues, specifically, due to failures of collection efficiency.

The FY19 target for distribution network losses or billing *in*efficiency (which is 1 minus billing efficiency) was 14.2% across India (weighted average), while for collection *in*efficiency (which is 1 minus collection efficiency) the regulator-set target was 0.2%, leading to a total AT&C loss target of 14.37%.[14] Compared to the targets, the actual billing inefficiency (i.e., distribution network loss) was 16.34%, while the total collection loss was 6.77%—a figure that combines non-collection from consumers and state government non-payment of subsidies. Thus, in FY19 the financial hit from under-collection was much higher than from billing inefficiency (distribution network losses) given the financial implications are based on deviations from targets, and not absolute losses.

Changes in Costs: Ex-ante to Ex-post

Figure 8 shows the deviations in costs between *ex-ante* and *ex-post*. Components of the rise in cost are higher PPC, non-PPC increases (which spans finance, operations, employees, etc., but no consistent breakdown is available in *ex-ante* data), as well as higher costs due to increased distribution network losses (excess billing inefficiency than targeted). It's worth mentioning that the base cost structure includes 0.07 Rs/kWh of costs carried forward from the past, i.e., Trued-Up from around FY17 or even prior years.

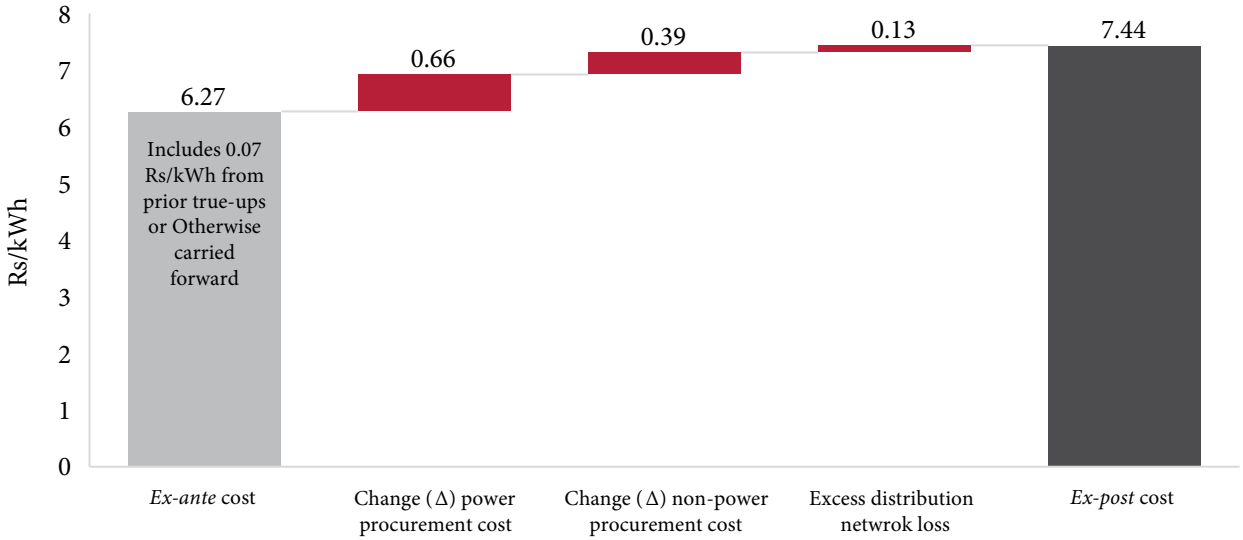
The biggest change in cost components on average from *ex-ante* to *ex-post* is for the change or delta in PPC *rate* (the cost per unit procured from generators). Figure 7 showed the heterogeneity of DisComs for deviations in total costs. If we examine only shifts in power procurement costs, 90% of units reported at a DisCom level were purchased from generators (inclusive of transmission costs) at higher *ex-post* prices than *ex-ante*.

The PPC rate rose by 0.66 Rs/kWh,[15] but given power purchase costs are about 80% of the FY19 *ex-ante* cost structure, this is a 13% deviation *ex-post*. In contrast, the *ex-post* increase in non-PCC costs per unit was Rs 0.39/kWh, but, because of its smaller base, this is a 31% rise on average.

[14] Because AT&C is a loss measure, it is useful to think of its components in terms of inefficiency, specifically billing inefficiency and collection inefficiency. The mathematical formula for AT&C loss in percentage is $\{1 - (\textit{Billing Efficiency} \times \textit{Collection Efficiency})\} \times 100$. Billing efficiency measures kWh sold compared to kWh purchased by the DisCom, while collection efficiency measures money received for sale of power compared to the money billed.

[15] The PFC data for PPC indicate an *ex-post* PPC rate of 5.80/kWh, instead of 5.01 Rs/kWh from the Tariff Orders, which indicates a gross PPC rate rise of 0.79 Rs/kWh. However, a fraction of this increase in procurement cost was due to excess distribution network losses (excess billing inefficiency) and due to shifts in volume. When we separate these factors, we find the true change from procurement cost to be 0.66 Rs/kWh, as shown in Figure 8.

Figure 8: ACoS Change from Planned (*ex-ante*) to Actual (*ex-post*) (FY19)



Source: Authors' analysis.

Note: Δ = delta, meaning deviation, from ex-ante.

The total of estimated ACoS and different deviations (rates and loss) slightly vary from the aggregate ACoS. This is because the deviation in volume sold is embedded in the factors, and not separable because of data limitations at a sub-component level.
For reference, the planned power procurement cost was 5.02 Rs/kWh, the majority of costs.

The last component of cost changes is for excess distribution network losses (excess billing inefficiency). For the 48 DisComs shown in Figure 7, the excess distribution loss of 2.14% compared to *ex-ante* targets forced DisComs to purchase an extra 26.86 billion units or kWh. Because we don't know the marginal cost of procuring these incremental units, we can only estimate the incremental costs for these units based on the average cost structure, or average power purchase cost (APPC).[16] With this assumption, the extra power procurement cost due to Δ distribution network losses translated to an additional Rs 10,944 crore, or Rs 0.13/kWh electricity sold.

While excess distribution network losses are the fault of the DisCom, the first two cost components are ostensibly outside DisCom control and should thus be recoverable during the True-Up process, either in part or in full. We revisit this issue subsequently.

Changes in Revenues – Ex-ante to Ex-post

Revenue side deviations or deltas (Δ) from *ex-ante* (planned) to *ex-post* (as-realised) are also significant, but the average change was lower than on the cost side. As Figure 7 showed, there was more heterogeneity across DisComs, with both negative and positives changes. On average, there was an *ex-post* revenue decline compared to *ex-ante* of Rs 0.40/kWh.

The per unit revenue deviation is caused by two broad reasons.

First, the energy sales mix can differ from *ex-ante*. Not only are the financials impacted due to selling less (or more) units in total, as discussed before

[16] Full calculations would require data on not only the costs of such incremental procurement but also whether such power led to average or different-than-average transmission losses.

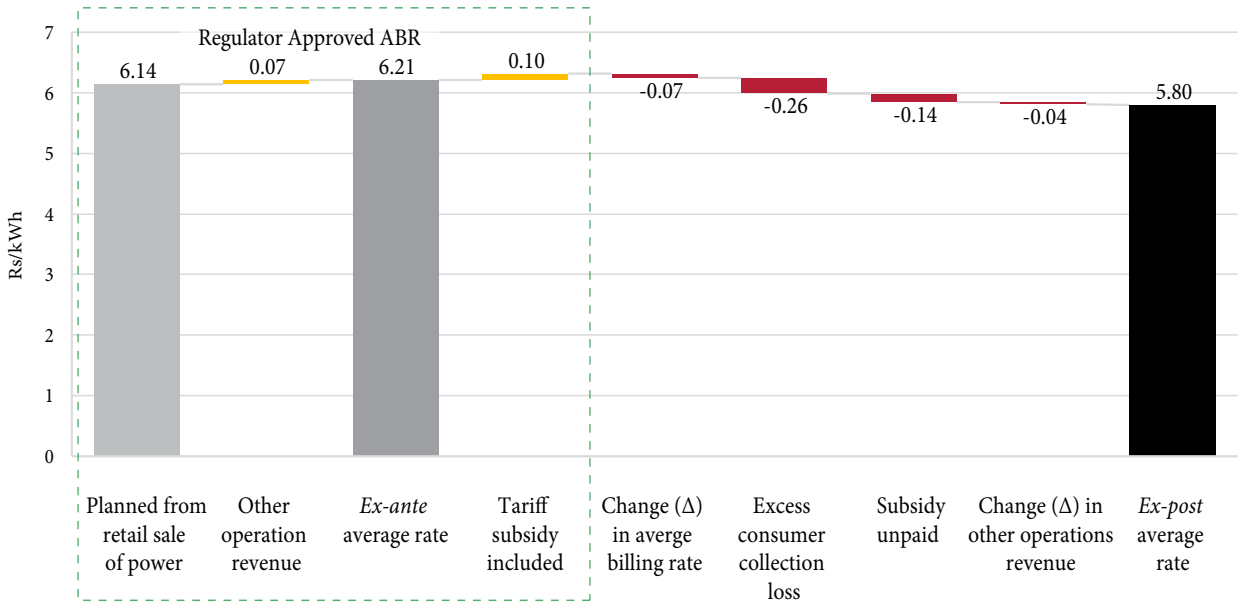
even for a constant volume of sales, changes in who you sell to (which consumer group) impacts the revenues. This is because of differential tariffs both across consumer groups (i.e., cross-subsidies) as well as progressive slabs (tiers) of pricing within a consumer category, especially in the Domestic (residential) category. As noted previously in Table 5, the change in volume was modest overall, and even the change in per category ABR was modest, except for the Other category.

In principle, these changes in revenues are not the fault of the DisCom, and should also be recoverable through the True-Up process. One could argue these are partly failures of planning, but if so, regulators should also take a measured call in what to project *ex-ante*, and not take the DisCom tariff petition (first step of the tariff process shown in Figure 1) at face value.

The second cause of deviation in revenues can be due to DisCom non-performance, specifically, failures in collection (a subset of AT&C losses). As described earlier, we segregate failures in subsidy collection from failures to collect from end-consumers.

Failing to collect billed amounts from consumers are an operating loss, but show up in the balance sheet as a Trade Receivable. It's a different story when (or even if) the DisCom collects these. On the other hand, accounting is opaque on how unpaid subsidies are accounted for in the balance sheet. A complementary CSEP study by Devaguptapu and Tongia (2023) examines balance sheet issues in more detail.

Figure 9: ABR Change from Planned to Actual (as realised) FY19



Source: Authors' analysis.

Note: The Regulator-approved ABR for DisComs operations was Rs 6.21 /kWh. If we account for Rs 0.10 /kWh of subsidy taken into cognisance by regulator when setting lower tariffs, the final effective ABR was Rs 6.31/ kWh. Most regulators do not take cognisance of state government tariff subsidies when setting tariffs, which in aggregate are about Rs 1/kWh but are paid by the state government and should not impact the tariff. The volume effect is embedded in both the rates and losses and not separable because of data limitations. Fall in ABR is highest due to non-collection of consumer dues (Δ C-loss) but subsidy unpaid is also substantial (Δ S-loss).

Figure 9 shows the shift in revenues measured at an average per unit (kWh) sold level from *ex-ante* to *ex-post,* with a breakdown the components of the change.

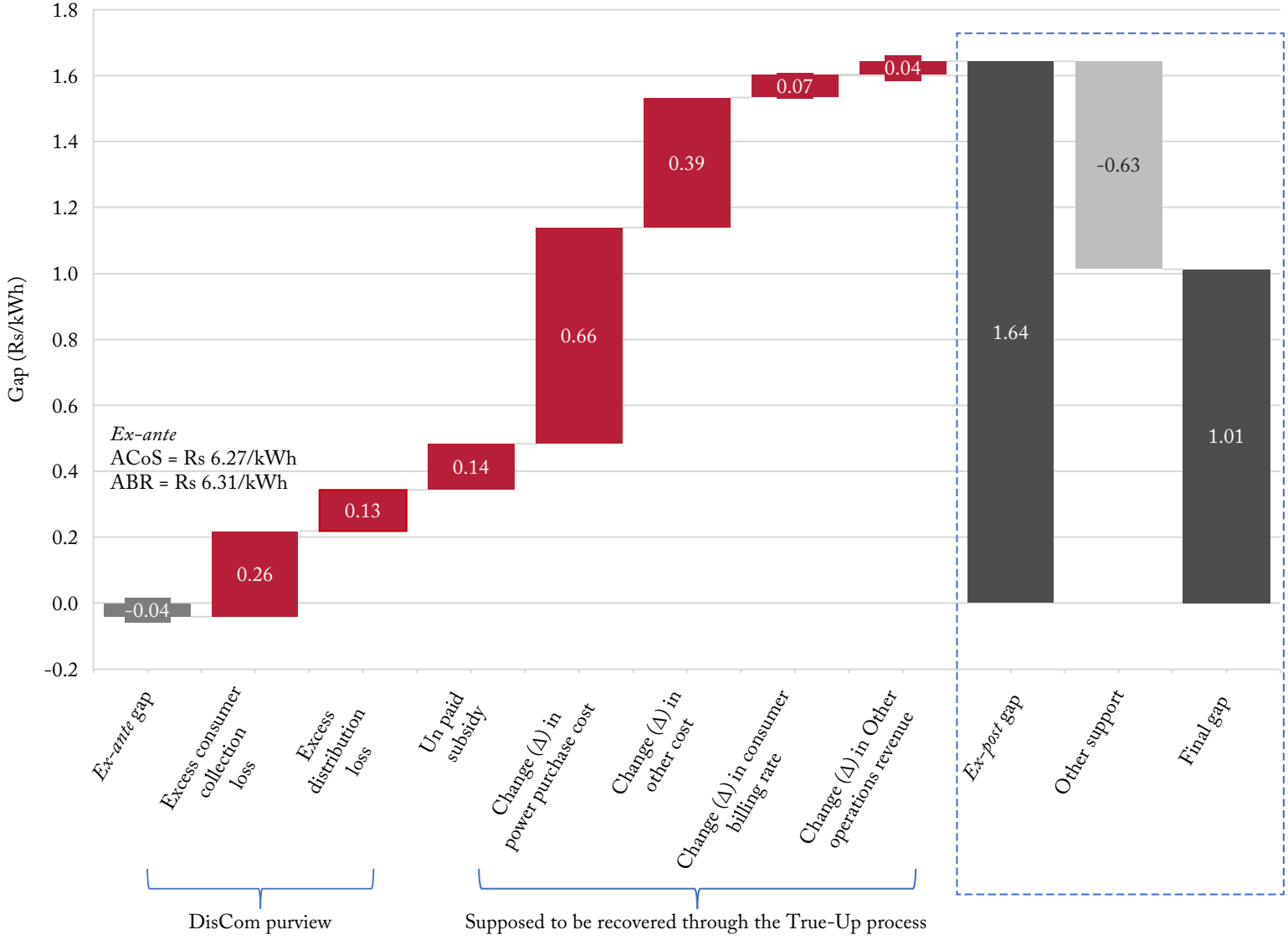
The green box is the plan as per Tariff Orders, which is mostly from end-consumers but also has 0.07 Rs/kWh from other operations like wheeling charges for non-consumers (such as third-party sales). We then show the money from subsidies that were taken cognisance of by a few regulators when setting a proportionately lower tariff—0.10 Rs/kWh in aggregate, but much higher for states where this happened. This means that the effective starting *ex-ante* tariff is Rs. 6.31/kWh, as shown in the *ex-ante* column of Table 5.

From this point, the change in ABR (i.e., change in consumer sales) was a fall of 0.07 Rs/kWh. Non-collection from consumers hit revenues by 0.26 Rs/kWh on average, while subsidy non-payment by states was 0.14 Rs/kWh on average, varying significantly by state. There was also a decline in other planned revenues by 0.04 Rs/kWh lowering total cash-basis per unit revenues to 5.80 Rs/kWh on average.

Putting Costs and Revenues Together – Ex-post Change in Financial Gap

Costs minus revenues give us the financial gap, if any. Figure 10 combines both sides to show the progression of the gap from *ex-ante* to *ex-post*. The total FY19 gap was 1.64 Rs/kWh. As discussed earlier, it's only with other income and support (like UDAY grants) that the gap comes to 1.01 Rs/kWh, shown in the blue box.

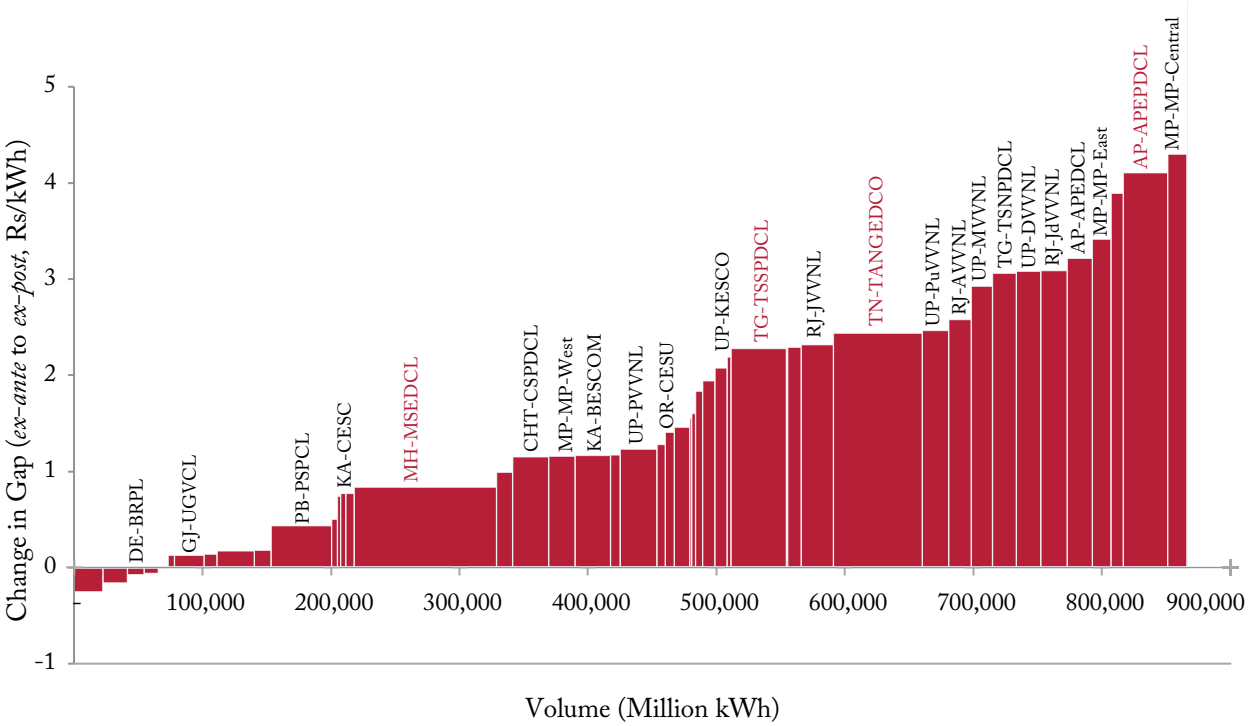
Figure 10: Planned to Final ACoS-ARR Gap Change Per Unit due to Changes (deltas) in Components in Rs/kWh (FY19)



Source: Authors' analysis.

Note: The sum of all the components adds up to Rs 1.66/kWh because of rounding errors. Changes ex-post that are not the fault of DisComs or other stakeholders should theoretically be recoverable through future True-Ups. However, actual True-Up levels have historically been lower than such recoverable gaps, e.g., the aggregate revenue requirement (cost structure) for FY19 only embedded Rs 0.07 of True-Ups from previous years.

Figure 11: FY19 DisCom-wise Distribution of Change in Gap between Costs and Revenues — Per Unit Change based on Final Volume of Sales



Source: Authors' analysis.

Note: Increasing gap means greater financial losses; only a handful of DisComs have ex-post improvements compared to planned. The top four DisComs by total ex-ante to ex-post change (in Rs crore, which is a product of per unit shift and volume of units) are shown in red, and cover 30% of the all-India change out of 48 DisComs. Not visible is Arunachal Pradesh, with the highest shift in gap of Rs 7.6/kWh but only 346 million kWh of sales).

Figure 10 shows that the components directly under DisComs' control, viz., Distribution Network Loss (billing inefficiency) and Consumer Collection Loss, are under a quarter of the total increase of 1.64 Rs/kWh in the cost minus revenue gap.

This national picture is based on a wide variety of changes varying by DisComs. Figure 24 in Appendix B1: ' DisCom-wise Details on the *Ex-Post* Financial Gap and its Causes' shows the change per DisCom, split between change in revenues and costs (and subcomponents). These figures are per unit. A more important macro picture emerges when we overlay volume data with change in financial gap between *ex-ante* to *ex-post* (Figure 11). The area of each block gives the total rupees impact. There are many DisComs with a low per unit gap but large volume, and also vice-versa. While the total shift is important, per unit shifts in gap (costs minus revenues) are quite telling—as high as multiple Rs/kWh. We note that a few DisComs have disproportional impacts, e.g., Maharashtra State Electricity Distribution Co. Ltd (MSEDCL) and Tamil Nadu Generation and Distribution Corporation (TANGEDCO). Only a few DisComs find a net improvement in gap, on the left-hand side.

As discussed previously, many of the changes are theoretically meant to be recovered through True-Ups, especially changes in power procurement costs, ABR, and non-power-procurement costs. However, given True-Ups take a few years materialise, at the time of analysis we didn't have complete availability of such True-Ups. However, we do note that the cost structure within the FY19 Tariff Orders embed historical True-Up costs from approximately FY17 (sometimes older). Surprisingly, this was only 0.07 Rs/kWh. This is only a fraction of FY17's calculated *ex-post* gap. A complementary study at CSEP by Devaguptapu and Tongia (2023) examines the time series of the financial gap across DisComs.

The data emphasise not just the limits to AT&C improvements to bridging the financial gap, but also the heterogeneity. In 20 DisComs, the Δ distribution network loss was actually negative, meaning they performed better than the targets (many regulators let them keep half the over-achievement). For many discoms, the real problem remains the other gaps (both procurement costs and other operational/financing costs).

This isn't just a One-Time (FY19) Issue

While our study focuses on FY19, we have done time-series checks on several DisComs, and the issue of a huge deviation from *ex-ante* to *ex-post* is a consistent trend.

Taking Rajasthan's Jaipur Vidyut Vitran Nigam Ltd (JVVNL) as an example (as shown in Box 2), we examine their *ex-ante* to *ex-post* changes in both costs (ACoS) (Figure 12) and revenues per unit (ABR) (Figure 13) over five years. No single factor dominates the cause of the shift in gap over, and the relative importance of the causal factors varies over time.

The financial change from *ex-ante* to *ex-post* and consequent implications are perennial. Devaguptapu and Tongia (2023) found that over 15 years, DisCom underperformance on AT&C losses within their control is an important but not dominant factor.

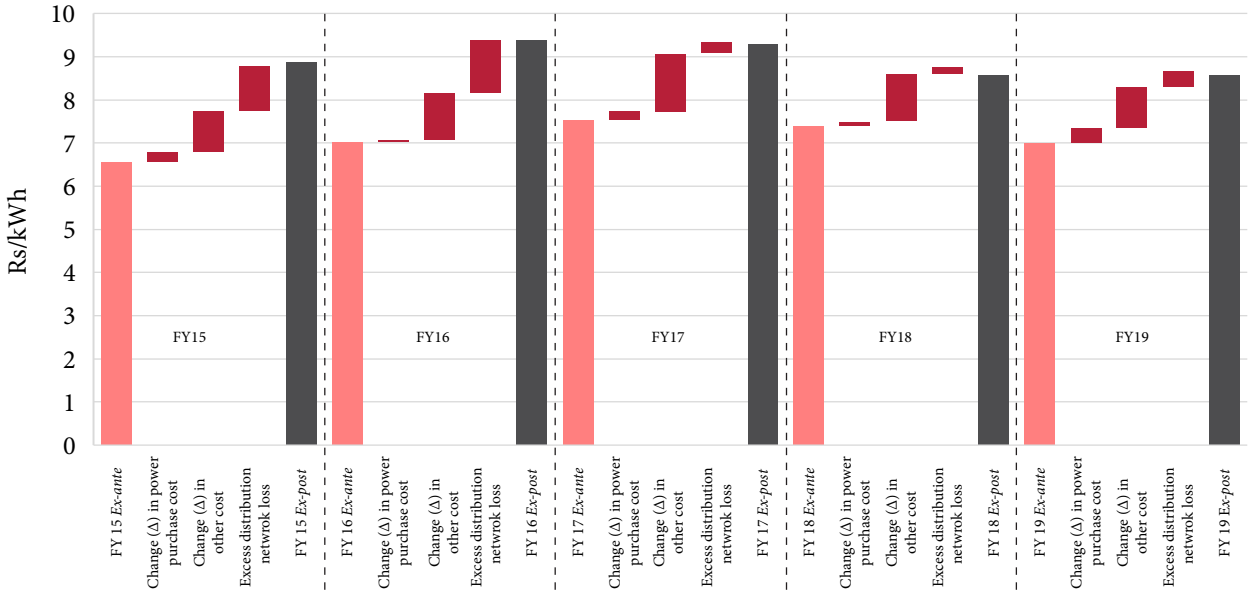
Box 2: *Ex-ante* to *Ex-post* Change in Gap over Five Years – The Case of a Rajasthan DisCom

In Rajasthan, JVVNL shows a consistent pattern of *ex-ante* to *ex-post* change in cost and revenue. *Ex-post* costs are always higher, despite a measurable improvement in distribution network losses, seen as a declining excess distribution network loss. Nonetheless, JVVNL needs to focus on further improving distribution network losses that are ~20%, roughly 4% higher than the all-India average of 16%.

Similarly, *ex-post* revenues (Figure 13) are always lower than projected *ex-ante*, though the contribution of falling ABR rates is declining. Initially, change in ABR and excess consumer collection were two major factors. In the later years, after FY16, one-third of the *ex-ante* to *ex-post* ABR increase was due to non-payment of tariff subsidy.

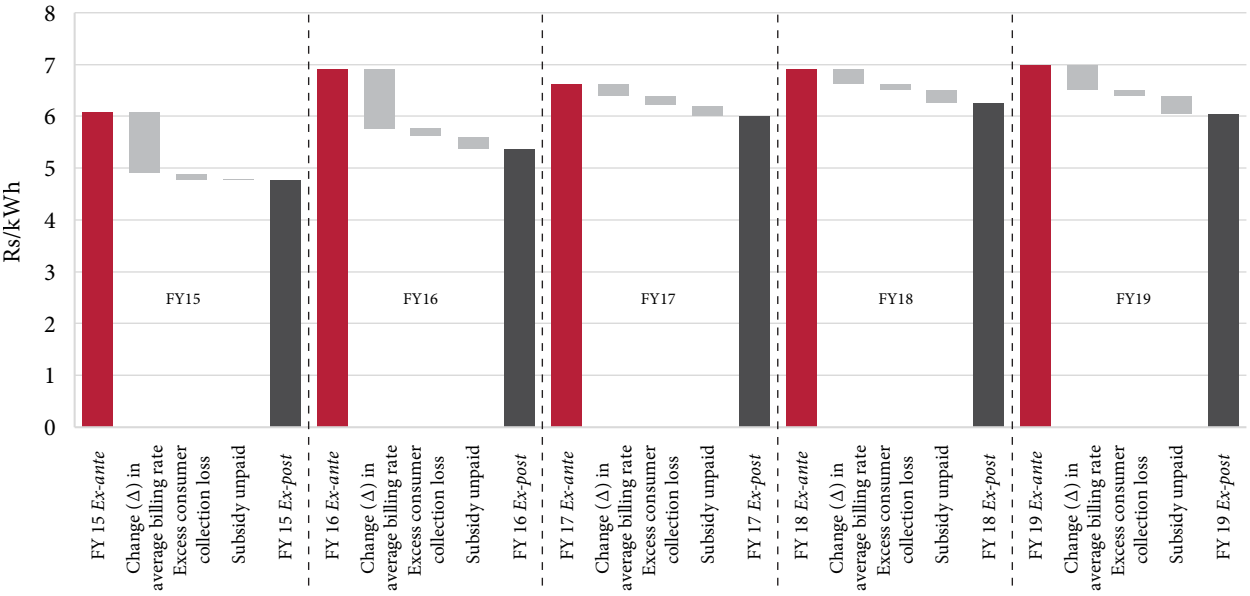
For JVVNL, reaching the target of 15% for distribution network losses and timely payment of promised subsidy will be important for their financial balancing.

Figure 12: Rajasthan's JVVNL ACoS Deviation Breakdown over Five Years



Source: Compiled from multiple years' Rajasthan Electricity Regulatory Commission (RERC) Tariff Orders.

Figure 13: Rajasthan's JVVNL ABR deviation over five years



Source: Compiled from multiple years' RERC Tariff Orders and ex-post data.

Note: ABR (DisCom-wide in this case).

Discussion: High Subsidies, Wide Financial Gap, and Implications

Highlights

- *Ex-post* cross-subsidies are much higher than *ex-ante* because of the rise in average costs. Compared to *ex-ante,* the *ex-post* underpayment by some classes of consumers has doubled, with an increase of Rs 72,928 crore. Similarly, the *ex-post* overpayment reduced by Rs 22,192, which is one-third of the *ex-ante* overpayment for the DisComs under study.
- The True-Up mechanism to reconcile tariff gaps over time doesn't appear to work. In FY19 the historical True-Up embedded in the cost structure was only 0.07 Rs/kWh on average, while the gross gap (prior to other income and grants) was 1.64 Rs/kWh. Even DisCom non-performance like excess AT&C losses, which aren't meant to be recovered in future True-Up tariffs, can only explain a small fraction of the gap.
- The true cross-subsidy is likely much higher than we calculate as per current definitions, which are per consumer category compared to average cost of supply (ACoS). If we consider tariffs within consumer categories, factoring in consumer retail tariff slabs (tiers), the cross-subsidy becomes much higher. Many current calculations also ignore differentials between fixed and variable costs, something that makes many subsidies regressive (low consumers pay more per unit for fixed costs, sometimes impacting their average charges). In addition, the cost to serve is likely the reverse of current cross-subsidy trends, e.g., the highest payers (like Industry) are the cheapest to serve, and so proper cost estimates further raise cross-subsidies. This is also clear in international pricing comparisons across consumer categories.
- Cross-subsidies cannot be studied in isolation of subsidies, especially given some segments like agriculture enjoy both. Lowering cross-subsidies may simply result in a corresponding increase in subsidies.

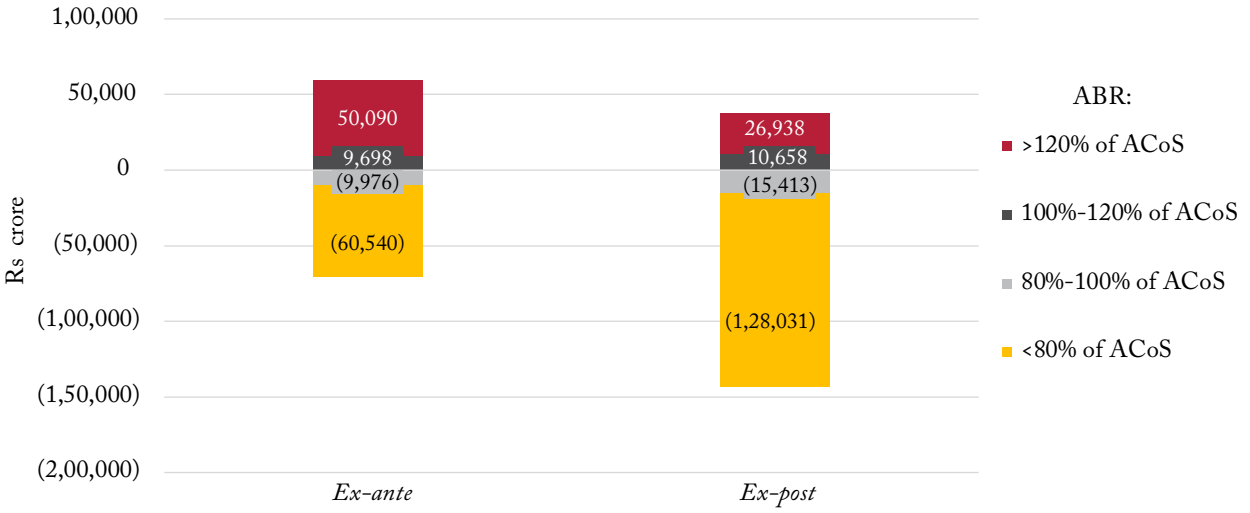
Shift in Costs Upwards Means Greater Actual Cross-subsidy

Because of the almost universally one-sided upwards skew in costs, *ex-post* cross-subsidies are far higher than originally planned in the Tariff Orders *ex-ante* (Figure 14). These are the aggregated figures at an all-India level.

For the 48 DisComs studied in detail (in Figure 7 and thus covered above) we find that compared to the *ex-ante* ACoS, the underpayment increased by Rs 72,928 crore and overpayment reduced by Rs 22,192 crore. Because we focus on Regular-set tariffs, *ex-post* numbers are after normalising for performance failures like collection efficiency lapses by the DisCom. The upward shift in costs combined with downward shift in ABR also means a greater shortfall of revenue. We discuss the implications of such gaps later, including how much of the gap can be recovered through the regulatory process in subsequent years (the True-Up process).

The share of units charged less than 80% of ACoS increased 19% from *ex-ante* to *ex-post.* On the other hand, share units charged beyond 120% of ACoS reduced by 20%. The change in ACoS is one of the major reasons for this change.

Figure 14: Approved versus Actual Cross-subsidy (Rs crore) on Billing Basis (FY19)



Source: Authors' analysis.

Note: Cross-subsidy is as per regulator-set tariffs, and thus calculated after correcting for DisCom performance such as collection failures.

The ex-ante (approved) figures aren't symmetric over versus under because of Rs 8,900 crore of subsidies taken into cognisance by selected sate regulators for some DisComs.

Why is there a Gap *ex-post*? It's a Systemic Issue

Given Tariff Orders are created in advance and are reliant on a range of assumptions, it is inevitable that there will be some deviations *ex-post*. However, the changes are not just remarkably wide, there is a skew—more in cost than in revenue changes—which indicates it isn't just random, and likely reflects deeper systemic and consistent issues. Even worse, the rectification process (True-Ups) seems to be unable to bridge the gap, even after normalising for things that should be disallowed in True-Ups, like DisCom non-performance.[17] Why does this happen?

It is widely known there is pressure to keep consumer prices low. In theory, regulators are neutral, but their staffing does have links to the state—Members of the Commission are appointed by the state government, and their other staff and funding are linked to the state as well. DisComs are owned by the state, and thus they would be even more inclined to strive for low tariffs.

The first step would be to see if DisComs are asking for lower ARR (annual revenue requirement) and thus cost structure than they truly need. Unfortunately, we do not have that level of data available across DisComs. Even when True-Up data are public, they lack a range of specific details. We do know from multiple newspaper reports that it is normal for regulators to deny the full ask by DisComs in Tariff Petitions (PTI, 2022).

[17] A complementary CSEP study examines the time-series impact of excess distribution network loss and collection failures, and their impact on the balance sheet. It finds that in the past, excess distribution network losses were a significant factor but have diminished over time.

The Processes – Including True-Ups – Have not Sufficed

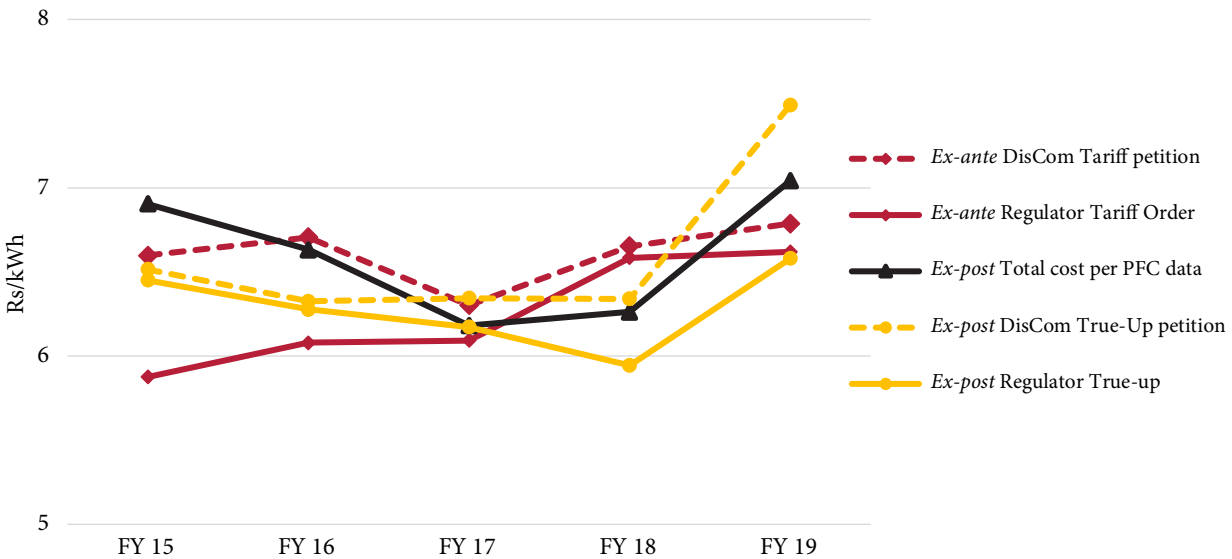
We examine the above questions using the case example of Paschimanchal Vidyut Vitran Nigam Ltd (PVVNL) in Uttar Pradesh, showing five years of all the steps of the tariff process, from: (1) *ex-ante* [a] Tariff Petition, to [b] Tariff Order, to (2) *ex-post* [a] what actually happened, to [b] True-Up Petition, to [c] True-Up Order (Figure 15). Note that the years shown are for the year of applicability, and not the physical time when the step occurred, e.g., the FY17 tariff True-Up may have happened in FY19, but it is shown as part of FY17.

All the petitions (dotted lines in Figure 15) are higher than approved in their respective Orders, both for the initial petition *ex-ante* and the True-Up *ex-post*. What is surprising is that in the initial years, the True-Up petitions were not just lower than the initial asks, but also lower than the actual costs (in black in Figure 15). DisCom non-performance does not explain the difference. Going through the petitions, orders, etc. in some detail, there are a range of factors that may be at play. First, there appears some level of auto-correlation—after years of receiving lower money, the subsequent True-Up ask (FY18 Tariff Petition) was higher than the costs for that year.

There are many subtle aspects that aren't well codified or standardised, especially when it comes to reasons for any disallowances. Many True-Up orders simply state what was allowed, without full explanations. In the case of UP, the regulator asked the DisCom to seek an additional subsidy from the state. Such a "subsidy True-Up" isn't common across DisComs. If DisComs don't ask for additional subsidy based on *ex-post* consumer mix and revenue changes , they would be left with a gap in revenues.

While a companion study at CSEP is focusing on time series analysis *ex-post*, we reiterate that FY19 Tariff Orders across India embed True-Ups of only about 0.07 Rs/kWh.

Figure 15: Uttar Pradesh DisCom PVVNL's Petitioned and Approved Cost (ACoS) Trend



Source: Compiled from multiple year Uttar Pradesh Electricity Regulatory Commission (UPERC) data spanning Tariff Petitions and Tariff Orders.

Thus, we do not anticipate that the FY19 Tariffs' subsequent True-Ups would recover all the *ex-post* gap of Δ PPC, Δ non-PPC, Δ ABR, etc. when they materialise.

Ex-post Costs End Up Higher – We Need Realistic and Better Planning

The issue doesn't just appear to be inaccurate numbers *ex-ante*, but unrealistic assumptions that create the skew. *Ex-ante* costs can be held low if the regulator disallows some costs, but a more subtle means through which this can happen is via unrealistic expectations on performance. An overly aggressive AT&C target lowers costs, but also sets up the DisCom for failure. This isn't to say AT&C targets shouldn't be tighter—they just need to be phased in. However, top-down pushes for tighter targets often become accepted outside the regulatory process. For example, as part of the UDAY scheme, many DisComs accepted tight targets with the central government that were tighter than what the regulators had set. Those superseded the original Tariff Order targets, but more DisComs then failed to achieve said targets.

Compared to AT&C losses, specifically changes in distribution network losses, far greater *ex-post* changes in costs come from changes in PPC and non-PPC.

Explaining the causes of the jumps of PPC and non-PPC is complicated, partly due to confounding factors and partly due to lack of data. Unfortunately, PPAs aren't public, and so we don't know the terms of sale in detail, especially not ones related to changes in volume. Similarly, we don't know all the details of who has issued debt (as an example) and at what terms. This is before even questioning the drivers for and utilisation efficiency of more debt or other finance—was it to add assets or simply as a stop-gap to cover operational losses?

Changes in volume are critical for PPC calculations because of how most power is sold in India, through PPAs. For PPAs with thermal (coal) generators, the generator tariff has two major components—fixed costs and variable costs (fuel, mostly). Fixed costs are paid regardless of offtake volumes by the DisCom. They are to be paid based on the generator being available for a specified level, typically 90% availability. On the other hand, the PPA assumes a normative offtake, typically 68.5% Plant Load Factor (PLF), when setting the price.

If offtake from a particular generator changes due to, say, changes in demand patterns or alternate supplies, then the DisCom is still on the hook for all the fixed costs. Thus, the average *per unit* PCC rate goes up at lower volumes, although the DisCom does still save fuel costs and thus overall costs.

However, this is only for power procured through a PPA. In theory, extra procurement under a PPA should be available simply by paying additional variable (fuel) charges, given fixed costs are already a sunk cost. For this to happen, the generator must have additional supply available at matching time periods. In case such extra power isn't available, then DisComs would have to procure power from third parties or the spot market (power exchanges). This not only requires covering total costs (fixed plus variable), it also exposes the DisComs to market volatility. While average power exchange prices have trended downwards over the years (until the post-COVID recovery and post-Ukraine crisis spikes), power exchange prices are higher than Average PPC rates for most peak period time blocks, when DisComs are more likely to need more power.

Power purchase costs can rise for reasons other than volume changes. Given fuel is typically a pass-through cost in PPAs, this is not just a

risk for DisComs but one where the price trend is typically one-sided upwards. However, fuel cost rises are adjusted quarterly in consumer bills as part of Fuel Adjustment Charges (FAC), (also termed Fuel and Power Purchase Price Adjustment or FPPPA charges). Hence, the *ex-post* ABR is already higher due to FAC that cover at least some of the rise in DisCom PPCs. For example, BESCOM (Karnataka) already had 0.16 Rs/kWh as FAC line-itemed and adding into consumer bills, and states with higher coal usage are likely to have higher FAC amounts.

It may also be the case that DisComs had to undertake a lot of unplanned power purchases, some of which the regulator may question and even disallow in the rate-base (though that is rare). There are also instances where some planned (contracted) supply is unavailable—India has already faced two major (coal) fuel shortfalls in eight months spanning 2021 to 2022. If this happens due to a contractual lapse by generators, the DisCom may find some relief in payables under the PPA, but they are still responsible for any ad-hoc procurement required to balance demand, failing which they would have to load-shed (cut supply to consumers). On the other hand, if there are shortfalls in supply from RE, there are limited penalties upon such generators, at least up to an allowed supply deviation measured in tens of percent.[18] By definition, RE increases planning risks because of its inherent variability.

While we do not have full data and thus cannot fully unpack all the causes of variations for their underlying details, it appears that the change in total volume of sales cannot explain the overall jump in costs. The FY19 increase in volumes was just 2% across India. However, changes in offtake at a generator and time-of-day (ToD) level are likely to explain much more of the PPC deviation.

We saw earlier that changes in consumer mix impact DisCom revenues due to differential tariffs. They also impact costs because different consumer types have different demand profiles, which impacts aggregate procurement profiles and thus procurement costs. For example, industrial consumers, who also happen to overpay, have demand concentrated in the middle of the day, which coincides with solar power. On the other hand, domestic users need power more in the mornings and evenings, which have historically been peak demand periods. While the consequent wholesale procurement by such consumers has ToD implications, their retail tariffs, for the most part, do not.

Issues of planning, contracting, and ToD are critical for controlling power purchase costs, and this will only become more important (and more complex) as RE rises. DisComs need to improve their long-term planning which can control power procurement costs. Relying on PPAs and simply passing on costs to consumers means an unnecessary risk of higher costs to consumers even if all costs are covered, or a persistent gap

[18] If a DisCom compares generator PPAs when it needs to lower offtake, a two-part tariff that separates fixed and variable costs (like for thermal generators) means the DisCom would simply buy from whoever offers the cheapest marginal cost of power. On the other hand, most RE PPAs are single-part (there is no fuel). Hence, if a DisCom lowers offtake from such an RE generator when it is surplus in alternate supply, the DisCom would save the full per unit cost of the PPA. However, grid and policy guidelines indicate RE is a "must run" source. One complaint from generators is when DisComs limit offtake due to claims of "Section 11"—the rule within the Electricity Act that allows actions for grid security and stability, which would give them a financial reprieve. As Tongia (2018) points out, rising RE will need strict classification and declaration for the reasons for curtailment (non-offtake) of RE.

under today's equilibrium of low *ex-ante* cost structures. More granularity on consumer sub-categories, volumes, etc., used in tariff-setting increases the burden on the regulator, but it necessary for balancing consumer equity with cost-reflective tariffs.

What Happens Because of the Gap?

On a single year-analysis, the revenues to costs gap would appear devastating. A small gap would simply mean lower profits (returns on equity) for the DisCom, but most gaps are far higher than any equity margin. Even if causes like increased PPC or changes in ABR (due to consumer mix changes) are allowed in full, this remains a burden on DisComs on a cash basis since the reconciliation ("True-Up") will take at least two years in theory.

The cash-basis shortfall of DisComs manifests itself through a number of means. First, DisComs need additional capital, which could be in the form of equity, debt (including working capital), etc. A parallel study at CSEP is looking at such issues. In addition, the cash shortfall is a key reason for delayed payments to generators (as per PFC, Rs 2,27,018 crore by FY19, and rising), or delayed salaries to staff in some cases.

Even when the regulator recognises higher costs *ex-post*, they doesn't always notify a commensurately higher tariff to cover costs, creating Regulatory Assets, yet another coping mechanism. This is a growing trend concentrated in a handful of states.

The cash-basis gap has real-world carrying costs, which, for example, Karnataka DisComs have claimed costs them 12% annually. When the gap results in delayed payments to generators, late payment surcharges (LPSCs) were as high as 18%, until the central government reduced them post-COVID down to 12%. The government notified new LPSC rules in 2022 that incentivise DisComs to pay off their generator dues spread over several years, by offering them a waiver on new LPSC interest charges as long as they are paying off the dues as per the agreed schedule.

One other implication of relying on True-Ups instead of setting more accurate tariffs up front, relates to an equity facet of the time-gap involved. The people who pay more later on as part of True-Ups or other adjustments aren't necessarily the same as those who paid less before. And it's not random—those who exit the system, such as with rooftop solar, tend to be overpayers and richer users.

Consideration of Other Funds and Subsidies

Ideally, SERC-approved tariffs should recover full DisCom costs. The revenues include not just those from the sale of power, but also other operations like wheeling power and open access surcharges. Many DisComs enjoy other grants from the state or central governments, but, in theory, those should not be part of the tariff-setting procedure. This because many of these funds are meant to cover either new schemes and capital expenses or help with historical deficiencies, and thus not be part of annual operations.

We saw in Figure 10 that DisComs benefited from 0.63 Rs/kWh of Other Income and Grants. These should be split up such that we know what funds came from the government versus from consumers, even if the funds from consumers are unplanned like from penalties. Fixed costs should be treated as consumer revenues, but line-itemed separately from energy-basis charges.

Factoring in such Other Income and Grants lowers the headline loss of DisComs, but policy should focus on bridging the entire gross gap of 1.64 Rs/kWh (FY19).

We've already mentioned the subtlety of a few states where regulators set tariffs taking cognisance of state subsidies and thus set lower tariffs. This is contrary to the Electricity Act 2003 which explicitly states that the tariff set by the regulator should be independent of subsidies. It is a distinct issue that promised subsidies aren't paid in time in many states, creating enormous cash flow burdens on the DisCom. The cumulative delayed subsidy payments from FY10-FY19 added up to roughly Rs 46,281 crore, which was about 10% of the total FY19 costs (Rajasekhar & Tongia, 2020). An ongoing CSEP study shows that the cumulative unpaid subsidy is increasing through FY21, and starting from FY07 the cumulative unpaid is close to Rs 90,000 crore, *excluding any carrying costs*. There are very few cases where regulators impose penalties on the state government for not paying subsidies on time.

Subsidies are an important tool for social welfare redistribution, but end up linking to cross-subsidies. Because states are cash strapped, there is pressure for lower tariffs specifically for sectors that are subsidised, such as agriculture. This lowers the subsidy burden for the state.

Consider the case of agriculture, where states announce subsidies ranging from "free power" (often upto a pumpset size limit) to reduced payments by farmers.

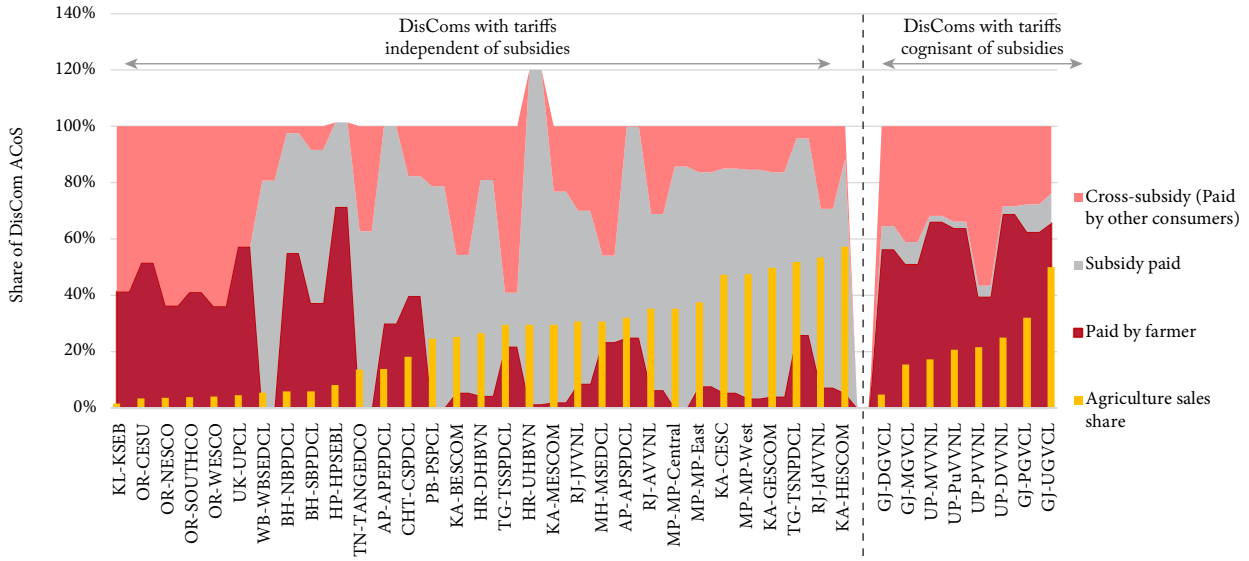
Figure 16 shows the combination of subsidies, cross-subsidies, and balance payments by farmers across India, as per FY19 Tariff Orders, and announced subsidies as compiled by us compared to the DisCom average cost. We segregate DisComs between those where regulators set tariffs independent of subsidies and where they recognise subsidies and thus set a lower tariff up front. Both sets are ordered based on share of total consumption by Agriculture.

We note several interesting trends. For many states with low agricultural consumption, there is no subsidy. Conversely, for the DisComs in the left portion of Figure 16, rising agricultural consumption correlates with a lower share of payment by the farmer, and rising subsidy. In fact, with rising share of agricultural consumption, we also have a lower cross-subsidy.

Not shown in this figure is the absolute ACoS across states. Independent of the ACoS absolute value, we note that regulators set high tariffs in a number of DisComs with high agricultural consumption. In Karnataka, Madhya Pradesh, Telangana (Telangana State Northern Power Distribution Company Limited; TSNPDCL), and Bihar the agricultural cross-subsidy is within 20% of ACoS. However, most of this tariff ends up being paid by the state, through subsidies. At the extreme, for Uttar Haryana Bijili Vitran Nigam (UHBVN), the regulatory tariff is high, but the cost is borne by the state, which pays 120% of the DisCom ACoS. This means that agriculture was subsidised by ~20% above ACoS.

Agricultural pricing is important not just from a fiscal balancing perspective but also broader accounting. Since most irrigation pumpsets are unmetered, DisComs have to make assumptions to calculate units consumed by agricultural users, theoretically based on hours of supply. This gives them leeway to hide losses by claiming higher-than-actual consumption in agriculture, if they so desire. Prayas Energy Group and other researchers showed that was the case in Maharashtra (MERC, 2020). Thus, in states with high agricultural tariffs but low consumer payments, the high taxpayer subsidy becomes a double whammy—first for the units and second for hidden losses parked under this category.

Figure 16: Share of Payment (by farmer, cross-subsidy, or subsidy) for Agricultural Consumers compared to DisCom Average Cost of Supply (ACoS) (FY19)



Source: Authors' compilation and estimations from SERCs and Tariff Orders.

Note: These are ordered by share of sales in agriculture (yellow bars) but split across states to the right where Regulatory tariffs reflect subsidies, in part or full, and are thus lower. Subsidy data are compiled and estimated from the different press reports, studies, PFC data, Tariff Orders, and Tariff Petitions. DisCom nomenclature is a combination of the state's name followed by DisCom, e.g., State = 'Delhi' and DisCom= 'BYPL' leads to DE-BYPL. See Appendix C for state and DisCom abbreviations.

As Figure 16 shows, fixing the violation in agricultural cross-subsidies could be done either through the end-user paying more, or states giving more subsidy. But both are difficult—doubling what the end-user pays (on a higher-than-average cost paid compared to in high-subsidy states) or finding sufficient state funds to cover the rise.

We are Likely Under-Measuring Cross-subsidies

Cross-subsidies are calculated based on two major assumptions or methodological choices, both in our study as well by regulators. First, the costs are based on the ACoS for the DisCom. This is widely accepted and even enshrined in Tariff Policy, but there are reportedly moves to update this benchmark. Second, the ACoS coverage by tariffs for consumers is based on the average for each consumer category, even though the norms only speak of consumer tariffs, without specifying whether this is for all consumers, even within a category.

Both aspects—average costs and averaged ABRs within a consumer category—likely underestimate cross-subsidies. This also has other large ramifications, such as for social welfare redistribution and the competitiveness of DisCom supply compared to alternatives. We examine these issues in more detail below.

True Costs Will Vary by Consumer Type

The cost of supplying an incremental unit of power to a consumer is complex and varies by the state of the grid, both at a congestion level and the source of generation, rather, the marginal source of generation, amongst other factors. Most pricing does some level of averaging, both for fixed costs and variable costs.

However, there is widespread agreement that at a category level, different consumer groups have different costs to serve. One could, in theory, calculate the average costs per group, which would factor in rural/urban mix, average times of day, capacity utilisation factors (a measure of average consumer load compared to their connection size), etc, but this is complex.

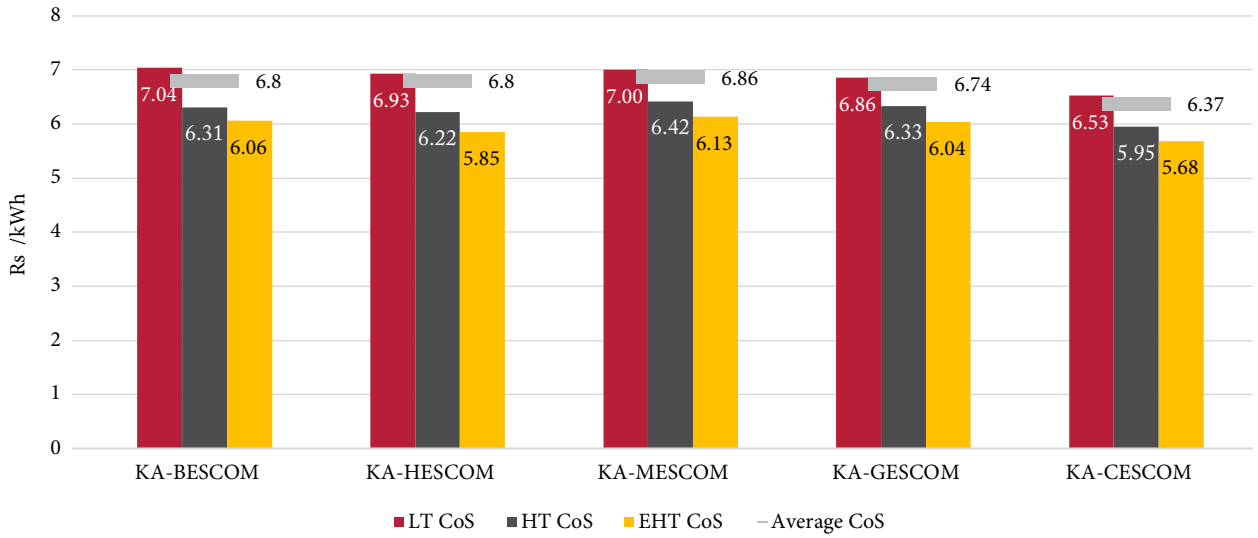
A far simpler but still more accurate split is to price costs based on low tension (LT, or low voltage, i.e., smaller) consumers versus high tension (HT, or high-voltage, or bulk) consumers. Many DisComs segregate tariffs by LT versus HT even for the same category such as Residential, Industrial, etc., like in the BESCOM example (Table 2). The Forum of Regulators (FoR, 2015) has suggested a move towards voltage-based cost of supply (VCoS), which reflects the fact that bulk consumers are cheaper to serve. Not only do they have lower line losses, but they also have a higher capacity utilisation factor (CUF). Per unit, they are also easier to connect and service.

If we use VCoS for establishing more accurate costs, the cross-subsidy gap would increase since retail tariffs are the reverse for the most part. This is because smaller consumers are typically charged less as part of social welfare redistribution policies.

Karnataka publishes VCoS data (KERC, 2018), and we can see the effect in Figure 17 for the state's five DisComs. The grey lines show the DisCom ACoS while we can see the split for LT, HT, and Extra-HT (EHT, the largest of consumers).

KA-BESCOM HT Industries (with an ABR of Rs 8.25/kWh) overpay by 21% per unit if we use ACoS as the benchmark, but overpayment rises to 31% when compared to VCoS. Because LT costs are higher than HT, overpayment by LT Industries will reduce to 17% per unit compared to 21% based on ACoS as the benchmark.

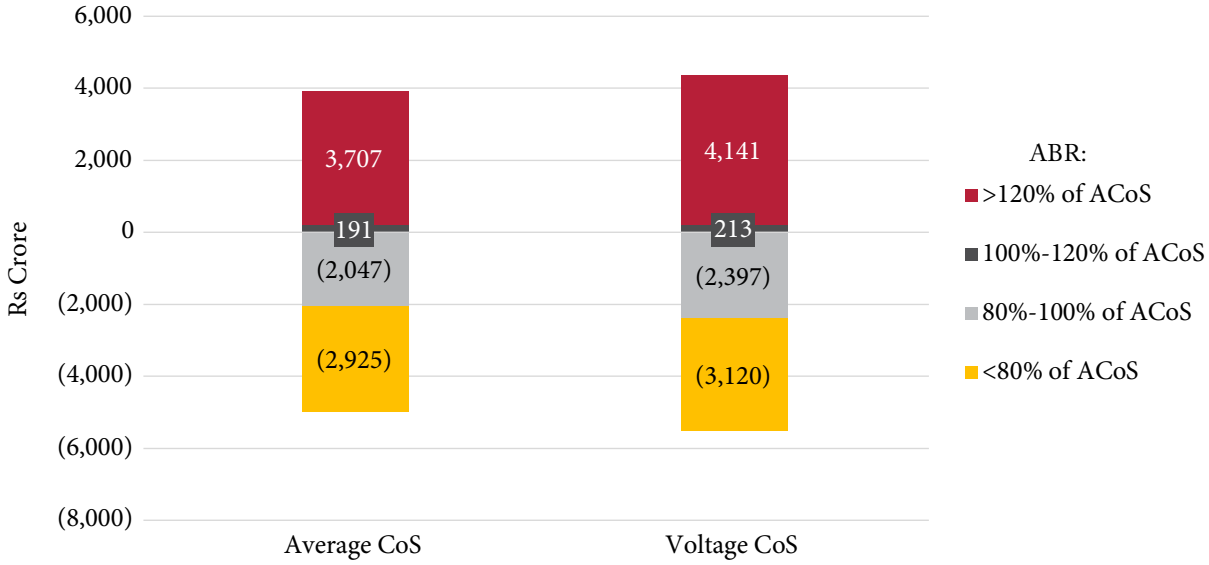
Figure 17: Karnataka FY19 CoS comparing Voltage-wise with Average CoS (VCoS vs. ACoS)



Source: KERC, 2018.
Note: LT = low tension or low voltage = smaller users; HT = high tension = bulk users; EHT = extra high tension = very high voltage = very large bulk users.

Calculating cross-subsidies based on VCoS leads to a higher cross-subsidy as shown in Figure 18, by almost 10% (more so on the over-payment side).

Figure 18: Karnataka Cross-subsidy by Different Cost of Supply (CoS) Benchmark Mechanisms (FY19)



Source: Authors' calcutions based on KERC, 2018 Tariff order.

Thus, if tariffs were to comply with the ±20% limit on cross-subsidies using VCoS, we'd need greater corrective swings, both for underpayers and overpayers. While VCoS pricing may be more accurate than today's system for establishing costs, this doesn't reflect time of day differentials by consumer types, and hence we need a balanced mechanism for categorising consumer groups.

Use of ABR at a Category Level also Understates Cross-subsidies due to Intra-category Variations

The normal interpretation of the rules is to examine consumer pricing through the category-level ABR. Policymakers should specify if this is the only guidance for examining cross-subsidies or should all consumers face limited cross-subsidies? As we will see below, this isn't just to lower payments for high users, but it can also help the poor.

As part of progressive pricing, regulators also have tiered consumption (variable, or energy) pricing within a category, mostly for residential users but also for many other categories. Variable charges are in the order of 90% of consumer charges (excluding taxes), varying slightly across utilities. Combined with undercharging for fixed costs (recovering more from variable charges to compensate, on average), this creates significant heterogeneity in what consumers pay per unit within a consumer category.

Table 2 listed the ABR per category for BESCOM (Karnataka). But this average includes both fixed and variable costs, as well as a range of slabs (tiers) for variable cost pricing. There can also be distinctions within what we group as Residential, such as differences for rural versus urban consumers, or between HT and LT consumers. Table 7 shows how variable costs for households can vary by more than a factor of two, excluding lifeline connections for the very poor (BPL users listed in Table 2 as *Kutir Jyoti/Bhagya Jyoti* users).

Table 7: Karnataka Retail Tariff Slabs for Domestic Users (FY19)

Consumer category	Type of charges	Sanctioned/ consumption slab	Tariff
HT-4 Residential apartments/Colonies	Fixed charges		Rs 120/- per kVA of billing demand /month
	Energy charges		Rs 6.45/kWh
LT-2(a) (i): Applicable to areas coming under Bruhat Bangalore Mahanagara Palike (BBMP), municipal corporations, and all other urban local bodies	Fixed charges per month	For the first kW	Rs 50 per kW
		For every additional	Rs 60 per kW
	Energy charges	For 0-30 units (lifeline consumption)	Rs 3.50/kWh
		31-100 units	Rs 4.95/kWh
		101-200 units	Rs 6.50/kWh
		201-300 units	Rs 7.55/kWh
		301- 400 units	Rs 7.60/kWh
		Above 400 units	Rs 7.65/kWh
LT-2(a) (ii): Applicable to areas coming under village panchayats	Fixed charges per month	For the first kW	Rs 35 per kW
		For every additional	Rs 50 per kW
	Energy charges	For 0-30 units (lifeline consumption)	Rs 3.40/kWh
		31-100 units	Rs 4.65/kWh
		101-200 units	Rs 6.20/kWh
		201-300 units	Rs 7.05/kWh
		Above 300 units	Rs 7.10/kWh

Source: KERC, 2018.

Even categories such as agricultural users can have vastly different pricing for irrigation pumpsets through sub-categories, e.g., UP's differentiation for public versus private users. This significantly impacts social welfare redistribution.

In UP, the ABR for private agricultural consumers is highly underpaying (Table 8) while state-owned agriculture connections have tariffs set to overpay above 120% of ACoS. Taken together, the ABR for the whole agricultural category is below 80% of ACoS. For PVVNL and Purvanchal Vidyut Vitaran Nigam Ltd (PuVVNL) the agricultural ABR is below the 50% of ACoS. The high charge for public tubewells may be a factor for governmental non-payments to DisComs,

Table 8: UP Agricultural Consumer ACoS Coverage (FY19)

DisCom	Consumer category	Sales (Million kWh)	Revenue (Rs crore)	ABR (Rs/ kWh)	ACoS Coverage (%)
DVVNL	LMV-5: Private Tube Wells	4,441	1,688	3.8	56.81%
	LMV-8: State Tube Wells	771	668	8.7	129.39%
	HV-4: Lift Irrigation	143	110	7.71	115.21%
	Total DVVNL Agriculture	5,355	2,466	4.46	66.67%
PVVNL	LMV-5: Private Tube Wells	6,600	1,026	1.6	29.84%
	LMV-8: State Tube Wells	629	467	7.4	142.68%
	HV-4: Lift Irrigation	0.38	0.30	7.9	151.53%
	Total PVVNL Agriculture	6,669	1,493	2.23	42.89%
MVVNL	LMV-5: Private Tube Wells	1,854	382	2.1	29.55%
	LMV-8: State Tube Wells	1,612	1,166	7.23	103.56%
	HV-4: Lift Irrigation	175	134	7.66	109.76%
	Total MVVNL Agriculture	3,641	1,682	4.61	66.04%
PuVVNL	LMV-5: Private Tube Wells	3,238	611	1.9	29.20%
	LMV-8: State Tube Wells	1,274	1,023	8.0	124.26%
	HV-4: Lift Irrigation	659	504	7.65	118.38%
	Total PuVVNL Agriculture	5,171	2,138	2.39	36.99%

Source: UPERC, 2019.

Note: For DisCom name abbreviations, please see Appendix C: Abbreviations and Explanations.

which is amongst the highest in UP. In UP's case, these tariffs are different by DisCom, but there are cases where different DisComs share identical tariffs per category despite obvious demographic and consumption profile differences (and thus different cost structures).

Such heterogeneity impacts not just what consumers pay but issues of equity. Delhi DisComs have shared granular intra-slab data with us, and we can see the effect in detail. Note that Delhi has wide slabs for consumption buckets, e.g., the entry-level slab (which inevitably covers poorer users but also many more) is 200 kWh/month (Table 9), almost double India's average monthly consumption. Delhi also has generous state subsidies, but our focus remains on regulator-set tariffs.

Table 9: Delhi Domestic Consumer Tariff Slabs (FY19)

Load category (sanctioned load)	Fixed charges	Energy charges (Rs/kWh)				
		Units				
		0-200	201-400	401-800	801-1200	>1200
Up to 2 kW	125 Rs/kW/month	3.00	4.50	6.50	7.00	7.75
>2 kW and ≤ 5 kW	140 Rs/kW/month					
>5 kW and ≤ 15 kW	175 Rs/kW/month					
>15 kW and ≤ 25 kW	200 Rs/kW/month					
>25 kW	250 Rs/kW/month					

Source: DERC, 2018.

Table 10: Delhi Domestic Consumer ACoS Coverage for Different Consumption Buckets FY19 (ABR to ACoS ratios)

Consumption slabs	DE-BRPL	DE-BYPL	DE-TPDDL
0 - <30	619%	445%	484%
30 - <50	130%	110%	128%
50 - <100	91%	80%	96%
100 - <150	75%	67%	81%
150 - <200	69%	61%	75%
200 - <300	70%	62%	77%
300 - <400	73%	64%	81%
400 - <500	78%	68%	87%
500 - <750	87%	76%	97%
750 - <1000	96%	84%	107%
1000 - <1250	103%	90%	114%
1250 - <1500	108%	95%	120%
≥1500	123%	106%	139%
Domestic Aggregate ABR	94%	73%	86%

Source: Authors' analysis based on data from the three Delhi DisComs.

Note: This is based on the calculated average connection size (Sanctioned Load) per consumption buckets shown, which are more granular than regulator slab boundaries.

Because fixed costs don't always have commensurate progressive pricing, the poor can pay much higher per unit of consumption in terms of ACoS coverage (because their denominator, or number of units consumed, is low).

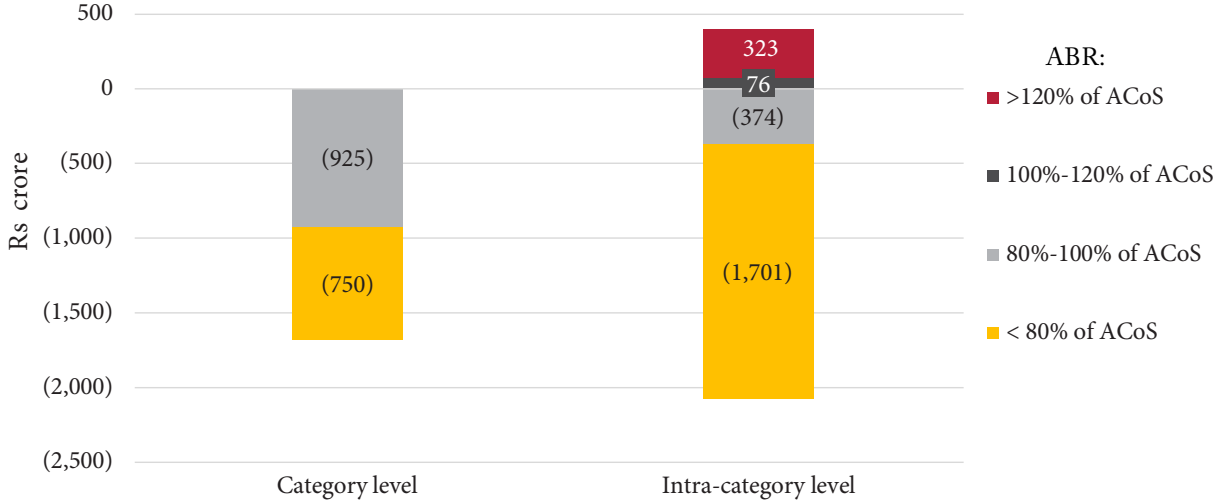
Table 10 shows the ACoS coverage for various slabs and sub-slabs, based on their average connected load per slab. Because of fixed-cost charges (not shown but calculated using the Tariffs in Table 9), the cheapest total pricing (lowest ACoS coverage) is reached only by 150-200 units of consumption. The lowest consumers, ostensibly the poor, pay the most per unit.

Consider an example of two consumers with different loads but the same sanctioned load (fixed costs). A consumer with up to 2 kW sanction load and 30 units (kWh) consumption will pay an average of 7.17 Rs/kWh, with much of this stemming from fixed costs (see Table 9 for the tariffs). On the other hand, a consumer with the same sanctioned load but 200 units monthly consumption, would have an ABR of only Rs 3.62/kWh, which is only 50% of ACoS. It is only with rising slabs would ABRs grow to 90-105% of ACoS (varying slightly across the three DisComs). Given volume is a proxy for wealth, this means the lower volume consumer pays more *per unit* than a higher-consumption and likely richer, consumer.

Delhi improved the social welfare redistribution of its subsidies by enhancing them from just covering 50% of energy charges to also covering fixed costs, something suggested in Tongia (2017). But subsidies aren't the only (or even best) instrument for protecting the poor. Improving social welfare redistribution is a complex issue that we revisit subsequently.

Delhi's intra-category tariffs and granular consumption data also allow us to study intra-category cross-subsidies, which become wider, as expected (Figure 19). Because of wider ABRs at an intra-category level, the cross-subsidy increases by Rs 400 crore in both directions, now even spreading into the red category (over-paying more than 120% of ACoS). Out of this overpayment, 34% comes from the consumption slab of 0-50 units (due to the high fixed charges).

Figure 19: Category versus Intra-category Cross-subsidy (Delhi 'Domestic' consumers FY19)



Source: Authors' analysis based on data collected from Delhi DisComs.

There are Likely other Hidden or Subtle forms of Cross-subsidy

There are likely other forms of hidden or subtle cross-subsidy beyond the two major ones given above based on the use of averages. These appear small in most cases but can be much higher in selected DisComs. However, we lack detailed data to fully quantify these issues.

As one example, consider how True-Ups are handled. Let us assume regulators recognise that there was a shortfall in revenues largely due to changes in one consumer category volumes or slab split. When this shortfall is allowed as a True-Up, this adds to overall DisCom costs as part of the ARR (annual revenue requirement) process (Figure 1) in future years, and is not charged to that consumer group individually. The same happens for any other cost that is part of the total DisCom rate base.

This issue of who pays how much is especially stark when we consider treatment of Electricity Duty (ED), which is not part of our analysis; ED is ostensibly outside the regulator's purview. The ED rates vary across states, and in some states like Maharashtra different consumer categories pay different rates, and this becomes yet another form of social welfare redistribution.

In FY19, commercial users in Maharashtra paid 20-25% ED, varying by consumption levels, while households paid less (15%) (CEA, 2019). Not only does this exacerbate the out-of-pocket payment differentials across categories, magnifying cross-subsidies, it could also be in conflict with cross-subsidy rationalisation. Cross-subsidy limit compliance at a regulator-set tariff level could simply be offset through ED rates. Consider the case where regulators must raise tariffs for an underpayer to comply with the ±20% cross-subsidy limit. Such consumers could be given relief through explicit subsidies, which could be funded by additional ED on other (higher) payers.

Fixing the ED issue and making sure it doesn't counter any fixes on cross-subsidies will not be easy given lack of clarity on regulatory authority. The SERCs have no jurisdiction. And while electricity is a concurrent subject under the Constitution of India, under both state and central government jurisdiction, taxes on electricity are entirely under state government purview (Seventh Schedule (Article 246) – List II – State List, Point 53). This is one reason it will take a constitutional amendment to add electricity under the Goods and Services Tax (GST).

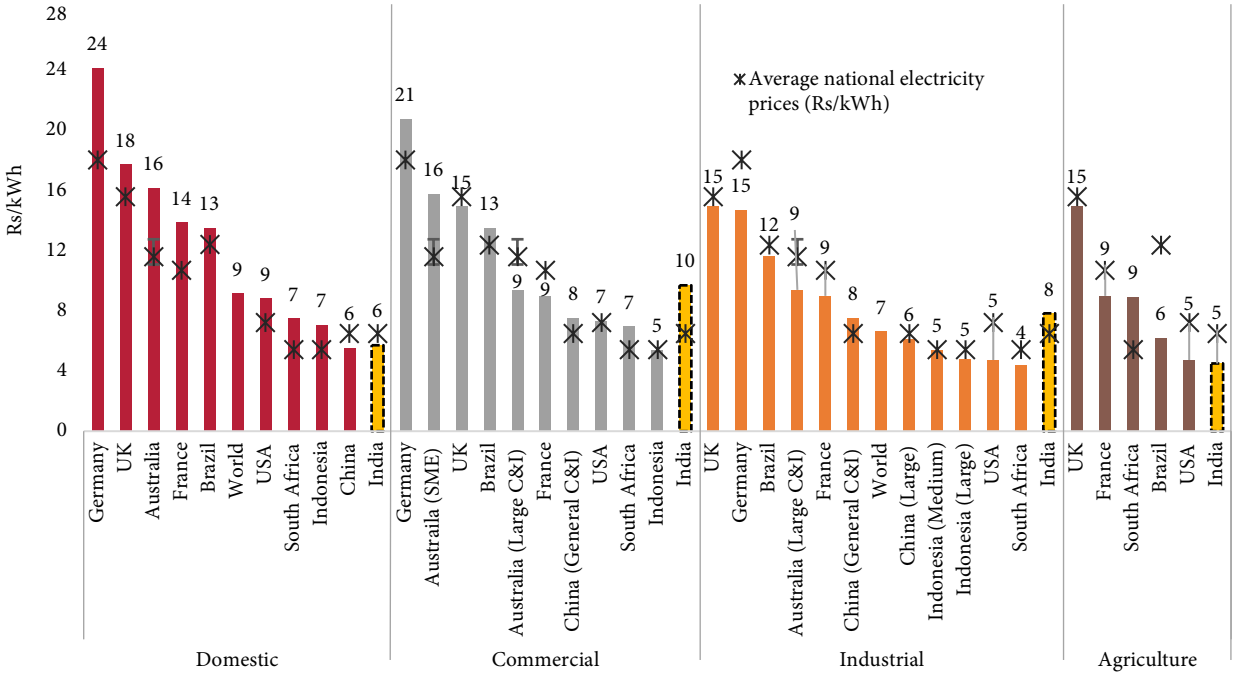
Proper Consumer Pricing – an International Comparison

Most Countries have Category Price Spreads that are Reverse from India's

The voltage-based cost of supply (VCoS) calculations shown in the previous section are based on how regulators currently calculate the costs for different voltage levels. If we consider international experiences for prices by category, we find VCoS may understate the differences in costs to serve different categories, which aren't just based on voltage but on average consumer load, location, time of day, etc.

Gokarn, Tyagi and Tongia (2022) have shown that other countries typically have lower charges for industrial users, and highest for residential. They show that if India were to price in a manner similar to the US, i.e., above and beyond simple VCoS pricing, then cross-subsidies would rise even further. Their international comparison is given in Figure 20, which covers total consumer charges including taxes and surcharges, and thus goes beyond just regulator-set tariffs (some regions only have market prices).

Figure 20: Consumption Category-wise Electricity Prices Across Countries (FY19)



Source: Figure 4 from Gokarn et al. (2022).

Note: The star shows the average price for each country; Australia's has an error bar because data only show the prices for bulk consumers versus small (especially residential) consumers. We assume a mix of anywhere from 25-50%.

South Africa's average prices reflect those who Eskom supplies directly. South Africa's domestic price also includes public lighting. Indonesia's prices are for non-subsidised consumers.

These are for FY2018–19 for India, and closest matching calendar year for other countries.

Gokarn *et al.* (2022) show how developed country power systems electricity prices are cost reflective overall and important for keeping the system viable. Price spreads by category are likely based on costs to serve. This means that in countries like the US, the United Kingdom (UK), and Germany, consumer prices are not just the reverse of Indian pricing by category, with Households paying higher than Commercial and Industrial categories, but price differentials (and thus likely cost differentials) are perhaps 2 times between the highest charged (Residential) and lowest charged (Industrial) categories. Even Brazil, South Africa, and Indonesia charge the Household category more than the average. As they point out, India's over-charging Commercial and Industrial consumers hurts economic competitiveness and productivity.

Mature Systems' Pricing Mechanisms Appear Better

International pricing mechanisms can also give us important insights beyond just what the prices are per consumer category. In areas where markets and competition determine retail prices, wholesale prices are the key determining factor, but we can limit ourselves to comparisons with areas where regulators are involved in setting retail prices.

The first layer of consideration would be whether there is a gap in regulator-set prices or not. Second, we're interested in pricing by category (shown in Figure 20). Lastly, we'd want to understand if there are major changes from *ex-ante* to *ex-post*.

A limited examination shows most other countries with well-functioning electricity systems rarely have large financial gaps between costs and revenues, and they also rarely have such large changes from *ex-ante* to *ex-post*. Why?

Developed countries don't have as high inflation as India, nor do they have such high growth in volume. Year-on-year changes are more modest, thus reducing the scope for errors. The flip side of this is that many of the financial problems in India have been managed only because of growing volumes, which increase gross revenues to pay off historical liabilities. While the low base of per capita electricity consumption in India today (about one-third of the global average), means that overall growth won't plateau any time soon, there is the likelihood that the growth of over-paying users will be slower than the overall growth. This is because of technologies like rooftop solar and also the rise of third-party sales. This trend puts severe pressure on the cross-subsidy equilibrium of today.

Why is it that most other countries don't have such a large gap *ex-post*—after all, all regulators have to make some assumptions when setting tariffs? There are two likely reasons.

First, the process is better, with better planning and better reconciliation where required. Ongoing work by Daljit Singh at CSEP finds that while Public Utility Commissioners (Regulatory Members) are political appointments in the US, the staff is neutral and highly qualified, including in economics and law. In India, SERCs don't have enough variety of domain experts, and some of their staff are on deputation from the utilities they regulate.

Second, most countries have far greater accountability than in India. If an entity in the West had repeated operating failures and financial gaps like in India, they would face severe consequences. Leadership may change *for cause* (distinct from India's rotating appointments of DisCom MDs), but companies would have to shape up or lapse into bankruptcy/receivership. There are examples of entire towns or cities in the West going into receivership until they get their act together. We don't have such a feedback loop. National Company Law Tribunal (NCLT) provisions have thus far never been applied upon DisComs, even though the rules have recently been clarified (PTI, 2021) that creditors who haven't gotten paid can start insolvency proceedings against DisComs. It is beyond the scope of this paper to delve into the possible efficacy or practicality of such steps.

While many countries have consumer pricing that covers DisCom costs and appears to price consumer categories closer to their cost to serve, they also face many challenges when setting prices due to ongoing energy transitions. As electricity economist Ahmad Faruqui (2022) has observed, balancing fixed versus variable costs was hard enough before regulators had to contend with end-user rooftop solar. Earlier RE policies focused on net metering, which priced solar power such that a consumer would feed into the grid at the same price as their marginal billing rate (effectively spinning their meter backwards), but such a system ignores ToD differentials. Because of this reason, India recently notified new consumer rules that limited the size of connections eligible for net metering (GoI, 2021). However, sooner or later, India will also need to revisit the social welfare equilibrium and broader pricing philosophy balancing not just DisCom

viability with consumer prices but also factoring in equity, efficiency, and environmental impacts.

The Equilibrium of Cross-subsidies is at Risk as High Payers could Leave the System

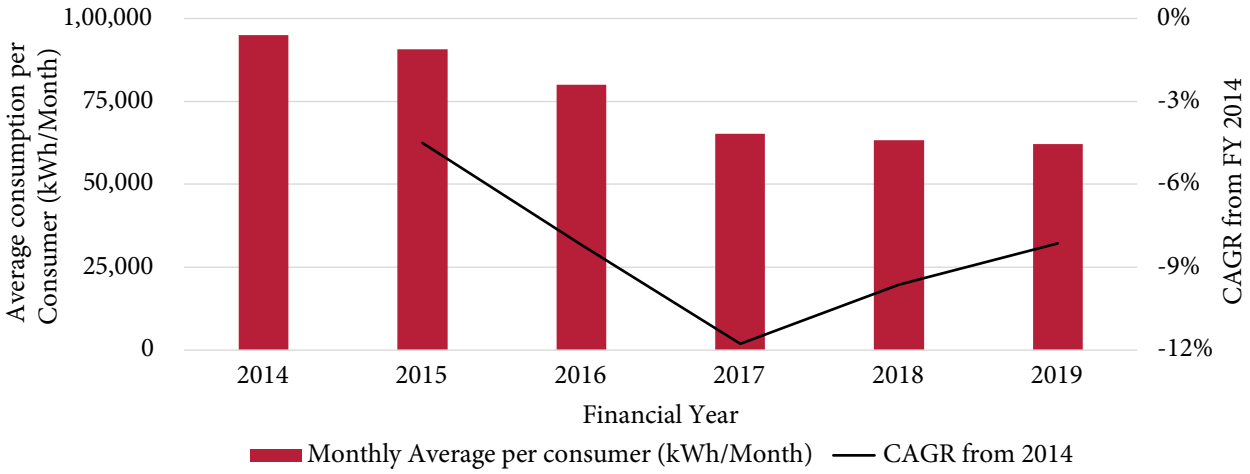
India's present equilibrium of overcharging some consumers, specifically, commercial and industrial users, cannot sustain. On the one hand, we've seen some of them need a tariff reduction to comply with the ±20% cross-subsidy limit, on the other, they also present a risk to the DisCom based on their either leaving or reducing offtake from DisComs through a combination of rooftop solar, Open Access (available to bulk consumers over one megawatt size who can choose their supplier), and other options spanning captive/group captive, third party sales, etc.

Reduced offtake is already happening in some cases. Figure 21 shows the declining monthly average consumption for industrial users in BESCOM (Karnataka) over time. While this example can be due to many factors, 41% of non-agriculture usage in Karnataka in FY19 was through open access and captive generation (Josey & Kokate, 2021), largely driven by high costs of utility-based supply. The recent central government's push for easier Open Access, such as through the creation of an Open Access Registry, will only increase the pressure from exit of bulk consumers. Such steps increase the burden on DisComs for proper planning.

The financial issue DisComs face isn't just a cross-subsidy compliance-caused loss of revenues from overpayers (which only applies for the portion of billing above 120% of ACoS), but the flight of units sold to such users.

As a thought exercise, we scope the *net* revenue at risk of flight from such users, based on FY19 Tariffs and *ex-post* volumes. Out of the total units above 120% of ACoS in tariff, we focus on Commercial and Industrial consumers—those with the greatest incentive and means to exit. Such units were Rs 79,346 crore in total value.

Figure 21: BESCOM – Consumption Trend of Industrial Users' (from Tariff Orders)



Source: Compiled from multiple KERC Tariff Orders.

We use ex-ante numbers because the number of consumers is not listed in PFC's ex-post data.

If such consumers leave, Rs 79,346 crore is a gross loss of revenue to DisComs, but for calculating the net loss we have to subtract the costs of service, dominated by power procurement costs. Since we don't know details of such units such as their time of day, grid status, market prices, etc., we conservatively use average power procurement costs (APPC) to estimate the avoided costs. For illustration in Table 11, we assume such consumers exit entirely, instead of just partly, and thus we might save on other costs like infrastructure as well, calculated pro-rata. Hence, the net loss to the DisComs would be Rs 22,725 crore, as broken down in Table 11.

Table 11: Overpayment by Commercial and Industrial Users at Risk of Leaving (based on *ex-post* FY19 data)

Total Overcharged Units – all categories (above 120% of ACoS)	88,729	Million kWh
Out of which: Commercial & Industrial users above 120% ACoS	82,490	Million kWh
Gross Revenue at risk if these overpayers (>120% of ACoS) exit	79,346	Rs crore
LESS:		
Change in PPC (at APPC level)	44,670	Rs crore
Change in Non-PPC (pro-rata)	11,951	Rs crore
Net revenue at risk (if all Commercial & Industrial users paying above 120% of ACoS exit the system)	22,725	Rs crore

Source: Authors' analysis.

Note: This APPC is calculated with total PPC, and not on the basis of variable costs only. Hence, if any consumer partially reduces consumption, such as with rooftop solar, the DisCom still pays generator fixed costs for the avoided power procurement, which could slightly increase the net revenues at risk.

As a comparison, let's assume such users they remain DisCom consumers but have their tariffs capped to 120% of ACoS. Using estimates for *ex-post* overpayment beyond 120%, capping cross-subsidies would reduce revenues to DisComs by roughly Rs 11,400 crore. Thus, between these two possibilities of losing the customer or having overpayments capped, DisComs either way face severe risks on the order of tens of thousands of crores of rupees per year (based on FY19 volumes and prices).

While Table 11 focused on those users who priced over 120% of ACoS, over time many other users might want to leave the system, especially as RE and storage technologies improve. It's also worth emphasising that the above calculations exclude any power procurement implications that may be asymmetric, especially keeping in mind ToD considerations. Worst for the DisCom would be to lose a high-paying customer whose demand coincided with cheap electricity supply. The above calculations also ignore intra-category spreads, which could increase the revenues at risk.

Tariff Changes and Other Steps: A Discussion on the Way Forward

Highlights

- **Higher Tariff:** Indian DisComs will need higher prices, both to comply with norms of cross-subsidy limits and to avoid a financial gap between costs and revenues. This is regardless of operational improvements like AT&C losses, which only help partially. Given the heterogeneity across DisComs, practical levels, timelines, and limits of rises will vary.
- **Reduction in cross-subsidy**: The present equilibrium of social welfare redistribution by overcharging commercial and industrial users will have to be fixed, sooner rather than later. Not only does overcharging hurt economic productivity and competitiveness, but ongoing technology and regulatory shifts will mean such users will be the first to move towards self-generation and third-party generation via renewables, such as rooftop solar.
- **Better tariff setting procedure:** Getting tariffs right isn't just an accounting challenge but one likely driven by political economy concerns, including widespread pressure to keep tariffs low. The consistent gap appears to be a problem with the entire tariff-setting process, which will need a revamp. This includes issues of estimations, (dis)allowed costs, and the True-Up process.
- **Transparent and consistent data:** A precursor requirement to setting correct tariffs is transparency and consistency of data. This begins with improved metering data and consumer measurements extending to financial data that today differ across DisCom annual reports, PFC reports, and Ministry of Corporate Affairs filings. Timely measurements and reporting are a start, and part of the government's plan under the Revamped Distribution Sector Scheme (RDSS).

As mentioned before, tariffs need to change and that would require rationalisation of the cross-subsidisation process and the overall tariff-setting procedure with the help of consistent data that is shared in a transparent manner. The rest of this section discusses these issues in greater detail under three main heads: (a) changes in tariffs, (b) norms, procedures, and enforcement, and (c) data, accounting and transparency mechanisms. We conclude by pointing out the need for urgency in undertaking these changes.

Tariff Changes Across DisComs – Heterogeneity of DisComs Offers a Blueprint for Distinct Approaches

As discussed, while rates for under-payers need to increase, partially offset by decreases in rates for over-payers, aggregate tariff rates need to be higher. We need a "cost-reflective" tariff in the aggregate. But there are many choices in how that average revenue per unit is to be distributed across consumers or consumer types. Say we need a tariff rise of 10%—should all consumers pay

10% more? Or, should underpayers face a higher rise? The latter option shows how cross-subsidies are linked to cost-reflective tariff setting.

Answering this question becomes even more complex when we consider changes between *ex-ante* and *ex-post*. Figure 6 showed a case of hypothetical revenue shift if only underpayers (below 80% of ACoS) saw a tariff rise but there was no tariff reduction for overpayers. This *ex-ante* surplus would mostly disappear *ex-post* given the rise in costs. Hence, this means there is almost no headroom to lower tariffs for what otherwise appeared to be overpayers (*ex-ante*).

Even if it is required, raising tariffs is easier said than done. The general principle of raising tariffs quickly becomes political, more so if this is done disproportionally for one consumer group. Unfortunately, the lowest-priced segments are the ones with the greatest political clout—Residential and Agricultural.

How much tariff rise is too much? Much more than inflation is likely to be considered burdensome, but legacy issues including cost structure and demographic differences are also factors in tariff rises. A DisCom with limited (or even nil) tariff hikes in recent years, for whatever reason, needs a large jump.

Any substantial rise needs to be spread out over several years. It is unlikely that the government could mandate (or even desire) overnight compliance. Three to six years is a reasonable range for staggering hikes. Thus, a 15% hike could become 3% (from today's levels) every year for five years, above and beyond regular (organic) price hikes occurring anyway. Even within a tariff hike of, say, 5% for a group of consumers, are all slabs meant to grow equally? Or, should lower-payers face higher rises? This may be economically efficient, but it's politically harder. We leave such details for future studies.

Box 3 in Appendix B2 illustrates a mechanism that could address such challenges in regulator-set tariff, by bucketing different DisComs based on their quanta of tariff hike required—some don't need an aggregate hike, while for a for few, compliance with cross-subsidy limits lowers their revenues. The analysis shows that while the challenges are significant, a structured solution is possible provided a one-size-fits-all approach is avoided.

Precursor Need: Clarity on Norms, Process, and Enforcement

Distinct from changes in tariffs is the need to eliminate ambiguity at tariff policy level on aspects of all three steps of tariff-setting that need to be clarified, namely ambiguity over: (1) the objectives and norms; (2) the process details, especially relating to assumptions and allowances/dis-allowances; and (3) enforcement of norms.

Expanding on these three issues:

1. The present norms only state cross-subsidies are meant to be within ±20%, but this doesn't clarify if this is only per consumer category (the norm today) or if it should apply to all consumers/consumer sub-groups, including at the slab (tier) level. The more granular one makes the limitations on cross-subsidies, the more tariffs will need to rise for many underpayers.

   In addition, cross-subsidies are presently benchmarked against DisCom-wide average costs (ACoS), but there is a case to be made for sharper differentiation and better measurement of costs to serve across different consumer categories. Such details on norms should come

from policymakers through the National Tariff Policy, and be implemented by SERCs.

Given the objective of cross-subsidies is social welfare redistribution, tariff calculations should go beyond energy tariffs and factor in total revenues from consumers, i.e., fixed cost tariffs. This could give some relief to small consumers who pay disproportionally more in fixed costs for their connection, leading to higher average charges per unit. Determining the best balance between fixed and variable costs and cross-subsidies remains a complex question where both tariff-setting philosophy and implications based on demographics will have to be deliberated transparently.

2. Even if we have clarity on the objectives and norms, there is far greater ambiguity on the process. When a DisCom petitions, either for the main Tariff Order or for a True-Up, they do not know the exact factor(s) that could lead to cost disallowance, and even the rationales keep changing time-to-time. While some aspects are clear, such as DisCom non-performance shouldn't be allowed in a True-Up, there is a range of reasons why the *ex-post* picture (both operationally and financially) may not match *ex-ante*. The ERCs should be transparent in what they do or do not allow, both to help DisCom petitions, and also in ERC tariff notifications.

   Regulators have a delicate balancing act to follow, and an important tool is transparency. Another possible tool is the use of benchmarks that should be updated proactively, even without a formal tariff-order petition. If a DisCom did face higher costs *ex-post* and is unable to recover such costs subsequently, it would always end up with a financial gap. On the other hand, a blanket allowance of all claimed costs would reduce incentives for DisComs to, say, find cheaper generation suppliers or cheaper finance.

3. Another pressing need is for enforcement of rules and regulations. Some violations are explicit, for which the only recourse for the DisCom is to go to APTEL (the uber-regulator above SERCs) or the Supreme Court. However, this is a lengthy process.

   On the other hand, there can be violations of norms for which there is presently limited regulator jurisdiction, and each case will need different solutions. For example, a number of states don't pay subsidies on time, hurting DisCom cashflows. Regulators should impose a penalty on the state government for such lapses. The central government is already in the process of notifying better accounting norms for subsidy payments versus non-payments, a welcome precursor step. Another example is when DisComs don't file a tariff petition on time—something the central government is cataloguing. Presently, there are limited regulatory repercussions on the DisCom or their owner (the state government). There are existing norms to allow *suo-moto* tariff orders by regulators, but rarely put in force. There are a number of rules that need updating, but we first need a timeline for universal compliance of regulatory norms.

Supporting Need: Improved Data, Standardised Accounting, and Transparency

Transparency is a key to not just increased awareness but also to measuring efficacy of any new policies or changes in the system. A dual of transparency is the need for simplicity and standardisation of accounts. Put together, these should lead to improved data, without which we risk not just non-compliance of norms but

also fudging of the data. We present Tariff Order data across 60 DisComs. Such data has not been compiled publicly before. Compilation is not easy, even if the government were to take up the exercise.

When we studied the meta-data, we found enormous variation and differences in the granularity of data. Slab boundaries and sub-categories are just part of the problem. The recent Power Ministers' conference in Udaipur (14 October 2022) showed that some states can have as many as 70 or more categories and sub-categories of tariffs!

This doesn't mean that all states must look identical, but that their differences should be easily assigned and reconciled across categories and sub-categories. Standardisation will help evaluate policy efficacy, especially aimed toward poorer users. Slab thresholds should align at key anchors, even if states want more slabs, and richer data should be gathered for the low end of consumption, expected to come from the poor. Delhi, an outlier, has an entry consumption slab set at 200 kWh/month that covered 60% of residential consumers in FY19.

Ex-post aggregation is limited to PFC's dataset, which is a very useful compilation, but its headings should align with those in Tariff Orders and DisCom annual reports. The PFC's data should also have more granularity, for example, total subsidies received should be broken down by consumer category. Ultimately, it's the DisComs who have to supply such data.

In both the Tariff Orders and PFC data, there should also be greater breakdowns of fixed versus variable costs. These will become increasingly important in a high-RE scenario, where variable energy costs will fall but fixed costs will rise. Such improvements will also be important under scenarios of retail competition or possible unbundling between wires and retail services (aka carriage and content separation).

We Need Better Data on Losses

The AT&C losses are a key metric for DisComs, but AT&C measurement has limitations as we've discussed, combining many aspects that should be segregated. kWh and rupee losses from lack of billing efficiency and collection efficiency, respectively, should be split up, and we need transparent data on both what actually happened *ex-post* and also the targets *ex-ante*. Even for collection from consumers, a subset of AT&C losses, total payments should be split up between those that are current dues for a customer versus past dues—the latter should be booked to the correct year.

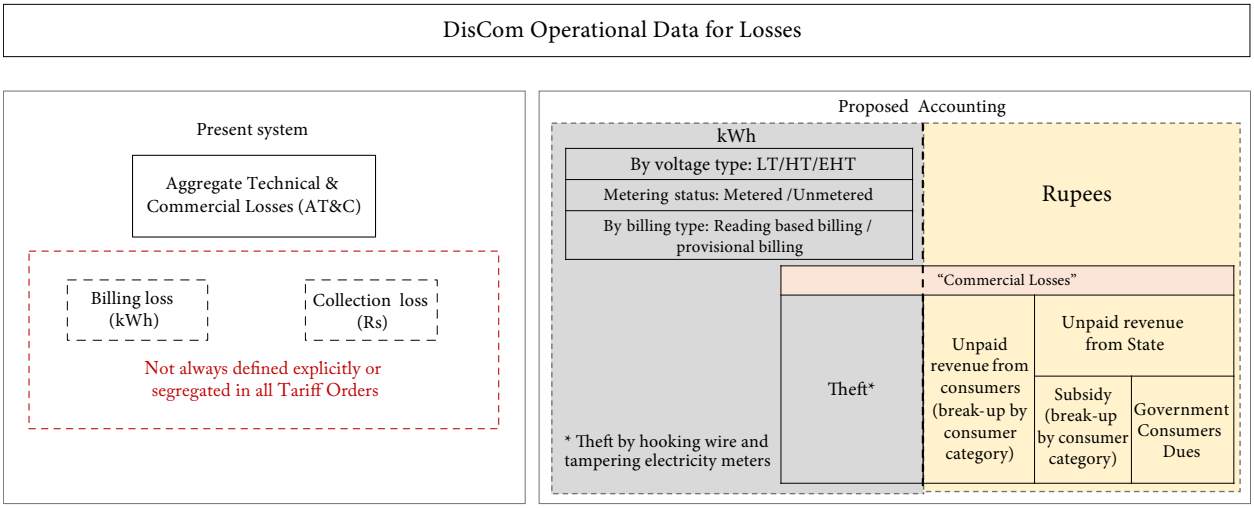
Each of the sides of AT&C should be further split. Billing efficiency should be split into the best possible estimate of theft versus technical losses, and the collection efficiency split into efficiency by end-consumers versus subsidy payments due. Figure 22 shows a proposed accounting framework.

While the proposed system appears more complex than the present system, it is simply more granular.

A key aspect of improved accounting starts with proper billing of units sold. Figure 23 breaks down the flow diagram of how billing should be split between estimated and true billing.[19] Not only

[19] Such billing improvements in accounting are primarily needed for LT (smaller) consumers, as most HT consumers have digital meters that are read using digital meter reading instruments, with data downloads.

Figure 22: Proposed Accounting Framework for DisCom Loss Parameters



Source: Authors' analysis.

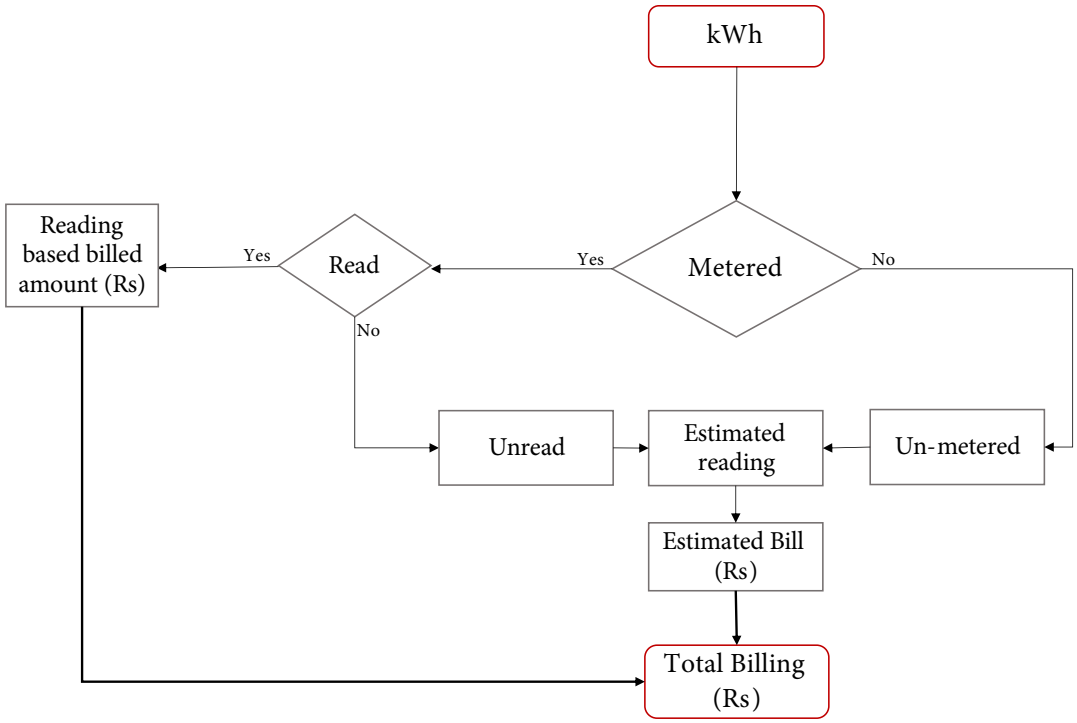
Note: Theft as listed in the schematic is purely in terms of energy (kWh) not getting billed, typically from physical means like "hooking" and meter tampering. There are other forms of theft not listed, such as when a consumer uses a connection for non-sanctioned uses, e.g., using a residential connection for running a commercial or industrial enterprise.

are many consumers not metered, even many metered consumers aren't billed on time, instead relying on provisional billing. One solution for this problem isn't just timely and proper billing but the use of smart meters, as emphasised in the current RDSS. These not only provide faster (and even real-time) billing, they also remove the human meter-reader from the equation, thus taking out a possible source of data fudging. They also allow remote disconnection of users who don't pay, which can cut down collection losses from consumers.

A major challenge is agricultural consumption, since not only are most pump sets unmetered, it is nearly impossible, politically, to meter them—DisComs actually cite a threat to life and limb if they try and do so! Unfortunately, until this loophole is somehow closed, perhaps through nudges that make metering palatable or group metering at a pole level, there will always be room for errors *or* manipulation in *ex-post* consumption data.

Financial Year 2019 still showed large swathes of the country with metering problems. For instance data on the metering status of JBVNL shows that even metered connection doesn't ensure actual billing (see Table 16 in Appendix B2). The problem is typically most pressing in poorly-performing regions of the country, but all-India aggregates are improving. Tabulating billing issues such as metered vs. unmetered, estimated vs. read, etc. are important in giving confidence bounds to official data on AT&C losses.

Figure 23: Proposed Flow Diagram for Accurate kWh Accounting



Source: Authors' analysis.

One other tool for reducing consumer collection losses is the proper use of consumer deposits. These are meant to be equal to two months of billing in most cases, but very often these are based on initial or planned connection profiles, which could be outdated. DisComs need to update the security deposit annually, based on changes in both ABR and volume, something Karnataka (BESCOM) does well, for example.[20]

More measurements, more reporting, and more dissemination of data aren't just for compliance's sake. They can help with improvements to the process. If we find an assumption in the tariff-setting process isn't working, or one DisCom is an outlier, this can help us update regulatory norms (e.g., on how much O&M expense inflation is allowed in the rate base).

The Central government is keenly aware of data quality issues, and PFC, in its 2022 report (with FY21 data), has started calculating cash-basis accounting as well. The Ministry of Power is also asking for timely Tariff Orders through formal reporting means. But the real challenges remain at the state level.

There is an Urgency to Tackle this Problem Head-on, Sooner Rather than Later

The more we delay addressing the problem of proper tariffs, the worse it will become for several

[20] DisComs owe consumers interest on such deposits, but methodologies for calculating the dues vary by DisCom.

reasons. First, underlying cost structures are only getting more skewed, in part due to the energy transition. As discussed earlier, overpayers are likely to exit the system through solutions like rooftop solar. Second, for any given (say) tariff change we need, spreading it out eases the pain, but waiting increases the jumps required in future years. Lastly, shifting public opinion and garnering decision-maker buy-ins to finally bite the bullet takes time, and are likely to be iterative, so we should start now, even if with baby steps that set the correct direction. The good news is that there is far greater awareness of the problem than ever before, and the government (especially the Central government, but even some state governments) wants to address the issues head on.

The analysis we presented was focused on FY19. Since then, we have significant changes in cost structures and even revenue mix. COVID-19 not only hurt DisCom sales in total, they lost Commercial sales the most, with a rise in Residential (work-from-home) sales. Russia's invasion of Ukraine raised global fuel prices, hurting coal imports. While India's power sector only imports a small fraction of its fuel needs, the price spikes have been in the hundreds of percent, thus raising overall costs (which ultimately consumers will have to pay). Lastly, India will need to finally install pollution control equipment on coal power plants to meet more stringent norms for air pollution—it has delayed doing so for several years. This will add tens of paise per kWh to coal power generation costs (Srinivasan, *et al.*, 2018). These rises in generation costs will require tariff increases, which lowers the headroom for raising tariffs to address the financial gaps identified in this paper.

If we step back and take a long-term view, much has improved with DisComs—household electrification is virtually 100% (though quality supply is still an issue), and on the supply side we largely have sufficient generation capacity. However, the financial losses of DisComs have remained high and nearly steady over the last eight years (Devaguptapu & Tongia, 2023). Fixing tariffs is the key to DisCom viability, and this doesn't mean just closing the gap between costs and revenues but getting consumer-level pricing right. More than just raw financial viability we must address issues of equity, energy security, and environmental sustainability. This is an unsolved problem that demands intense multi-stakeholder effort. This paper is an attempt at better understanding the problem and offering suggestions for improvement.

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Not listed are individual Tariff Orders per DisCom or their audited reports.

Appendix A: DisCom Details on Consumer Tariffs and Cross-subsidy Compliance Implications

Table 12: Cost (ACoS) Coverage Based on Major Category Aggregates as Per Tariff Orders FY19

DISCOMs	Domestic	Commercial	Industrial	Agriculture	Others	DISCOM ABR	ACoS (Rs/kWh)	Region
BH-NBPDCL	94%	119%	117%	98%	88%	98%	7.18	Eastern
BH-SBPDCL	93%	116%	102%	92%	109%	98%	7.49	Eastern
JH-JBVNL	83%	110%	141%	55%	106%	100%	5.86	Eastern
JH-DVC	95%	114%	90%	—	106%	91%	4.76	Eastern
OR-CESU	79%	138%	135%	52%	129%	105%	4.73	Eastern
OR-NESCO	72%	134%	122%	36%	128%	101%	4.78	Eastern
OR-SOUTHCO	86%	172%	141%	41%	154%	108%	4.30	Eastern
OR-WESCO	82%	143%	135%	36%	131%	111%	4.70	Eastern
WB-WBSEDCL	85%	117%	106%	64%	111%	98%	7.22	Eastern
WB-CESC	96%	118%	105%	—	106%	104%	7.02	Eastern
MG-MePDCL	69%	108%	99%	65%	94%	86%	7.65	North-Eastern
MN-MSPDCL	43%	60%	42%	32%	50%	46%	12.00	North-Eastern
MR-P&ED-M	47%	68%	62%	25%	37%	45%	8.90	North-Eastern
ARP-APDOP	29%	36%	26%	25%	27%	29%	13.32	North-Eastern
AS-APDCL	84%	128%	115%	109%	115%	100%	7.35	North-Eastern
NL-DPN	34%	53%	44%	31%	46%	41%	12.98	North-Eastern
CH-CED	81%	121%	116%	56%	120%	101%	5.16	Northern
DE-BRPL	81%	144%	125%	44%	100%	101%	7.47	Northern
DE-BYPL	79%	148%	127%	42%	87%	101%	7.41	Northern
DE-TPDDL	74%	151%	130%	73%	97%	105%	7.34	Northern
HP-HPSEBL	88%	109%	103%	104%	116%	100%	5.59	Northern
HR-DHBVN	84%	104%	112%	81%	103%	95%	6.51	Northern
HR-UHBVN	65%	88%	87%	120%	90%	92%	7.97	Northern
JK-JKPDD	43%	68%	70%	46%	101%	62%	5.84	Northern
PB-PSPCL	98%	115%	106%	79%	98%	97%	6.56	Northern
RJ-AVVNL	94%	137%	118%	69%	103%	96%	7.19	Northern
RJ-JdVVNL	98%	137%	120%	71%	109%	90%	6.97	Northern
RJ-JVVNL	98%	138%	118%	70%	106%	100%	6.99	Northern
UK-UPCL	80%	115%	110%	57%	103%	100%	5.05	Northern

UP-DVVNL	80%	116%	105%	69%	93%	85%	6.69	Northern
UP-KESCO	123%	224%	143%	—	210%	152%	5.11	Northern
UP-MVVNL	75%	152%	101%	66%	124%	88%	6.98	Northern
UP-PuVVNL	68%	140%	112%	64%	132%	83%	6.46	Northern
UP-PVVNL	104%	193%	134%	40%	165%	108%	5.21	Northern
AP-APEPDCL	63%	174%	110%	99%	107%	99%	5.85	Southern
AP-APSPDCL	64%	171%	118%	100%	106%	100%	5.90	Southern
GO-EDG	51%	102%	95%	33%	113%	84%	5.36	Southern
KA-BESCOM	87%	141%	121%	54%	104%	97%	6.80	Southern
KA-CESC	88%	150%	123%	85%	96%	97%	6.37	Southern
KA-GESCOM	98%	139%	125%	84%	94%	97%	6.74	Southern
KA-HESCOM	96%	145%	128%	89%	95%	98%	6.80	Southern
KA-MESCOM	91%	138%	118%	77%	100%	98%	6.86	Southern
KL-KSEB	68%	140%	115%	41%	104%	94%	6.11	Southern
PD-EDP	46%	115%	112%	6%	123%	90%	5.28	Southern
TG-TSNPDCL	103%	155%	124%	92%	89%	100%	6.29	Southern
TG-TSSPDCL	84%	170%	133%	40%	149%	98%	5.90	Southern
TN-TANGEDCO	60%	155%	132%	49%	135%	100%	5.84	Southern
CHT-CSPDCL	75%	138%	121%	82%	99%	100%	6.20	Western
DD-ED-DD	37%	63%	91%	14%	86%	87%	4.60	Western
DNH-DNHPDCL	46%	73%	88%	15%	80%	87%	4.92	Western
GJ-DGVCL	84%	102%	110%	56%	84%	100%	6.63	Western
GJ-MGVCL	96%	112%	125%	51%	87%	101%	6.18	Western
GJ-PGVCL	97%	126%	132%	62%	95%	101%	5.55	Western
GJ-UGVCL	107%	139%	158%	66%	104%	101%	5.13	Western
MH-BEST	82%	116%	110%	—	115%	100%	7.10	Western
MH-MSEDCL	104%	181%	124%	54%	111%	102%	6.67	Western
MH-RInfra-D	85%	119%	109%	84%	104%	100%	8.60	Western
MH-TPC-D	68%	129%	123%	—	116%	100%	7.39	Western
MP-MP-Central	102%	139%	106%	85%	111%	100%	6.08	Western
MP-MP-East	99%	133%	126%	84%	104%	100%	6.00	Western
MP-MP-West	102%	143%	120%	85%	111%	100%	6.02	Western
All-India	84%	132%	119%	70%	113%	98%	6.27	All-India

Source: Authors' analysis

Table 13: Cost (ACoS) Coverage and Category-Wise Tariff Changes Required for Compliance with Cross-subsidy Limits

	Sales Share (in %)					Tariff change to comply (in %)					
DISCOMs	Domestic	Commercial	Industrial	Agriculture	Others	Domestic	Commercial	Industrial	Agriculture	Others	DisCom
AP-APEPDCL	28%	6%	41%	14%	11%	25%	−32%	0%	0%	−9%	0%
AP-APSPDCL	26%	5%	28%	32%	8%	25%	−30%	−3%	0%	−5%	0%
ARP-APDOP	39%	14%	28%	0%	19%	182%	121%	212%	222%	193%	181%
AS-APDCL	55%	16%	18%	1%	10%	0%	−15%	−7%	−2%	−7%	−5%
BH-NBPDCL	61%	8%	10%	6%	15%	0%	−2%	0%	0%	0%	0%
BH-SBPDCL	55%	11%	22%	6%	6%	0%	0%	1%	0%	−1%	0%
CH-CED	47%	31%	16%	0%	6%	0%	−1%	−2%	43%	−1%	−1%
CHT-CSPDCL	27%	4%	39%	18%	12%	6%	−13%	−3%	0%	0%	−1%
DD-ED-DD	5%	3%	91%	0%	1%	118%	28%	1%	467%	2%	5%
DE-BRPL	59%	26%	4%	0%	11%	0%	−17%	−4%	84%	−2%	−7%
DE-BYPL	58%	28%	4%	0%	10%	2%	−19%	−6%	93%	1%	−7%
DE-TPDDL	47%	17%	27%	0%	8%	8%	−21%	−8%	10%	0%	−5%
DNH-DNHPDCL	2%	1%	97%	0%	0%	75%	10%	0%	440%	6%	1%
GJ-DGVCL	18%	32%	44%	5%	2%	0%	0%	0%	42%	0%	1%
GJ-MGVCL	29%	16%	36%	16%	4%	0%	0%	−4%	56%	0%	3%
GJ-PGVCL	17%	14%	33%	32%	4%	0%	−4%	−9%	28%	0%	1%
GJ-UGVCL	12%	9%	24%	50%	5%	0%	−13%	−24%	22%	0%	−4%
GO-EDG	27%	11%	58%	1%	2%	58%	−2%	0%	146%	−12%	10%
HP-HPSEBL	25%	7%	56%	8%	4%	0%	0%	0%	0%	−5%	0%
HR-DHBVN	24%	14%	28%	27%	7%	0%	0%	0%	0%	0%	0%
HR-UHBVN	24%	9%	32%	30%	5%	24%	0%	0%	0%	0%	4%
JH-JBVNL	62%	7%	26%	2%	4%	0%	0%	−15%	46%	0%	−5%
JK-JKPDD	45%	11%	19%	5%	19%	88%	18%	17%	73%	0%	36%
KA-BESCOM	26%	17%	22%	25%	10%	0%	−15%	−1%	47%	−8%	2%
KA-CESC	18%	7%	14%	47%	15%	0%	−20%	−3%	1%	−4%	−3%
KA-GESCOM	20%	6%	15%	50%	9%	0%	−14%	−4%	1%	0%	−1%
KA-HESCOM	17%	6%	11%	57%	9%	0%	−17%	−6%		−3%	−1%
KA-MESCOM	31%	12%	16%	30%	11%	0%	−13%	0%	4%	−1%	−1%

KL-KSEB	50%	21%	15%	2%	12%	18%	−15%	0%		1%	3%
MG-MePDCL	45%	9%	32%	0%	14%	18%	0%	0%	22%	0%	6%
MH-BEST	45%	38%	6%	0%	11%	0%	0%	0%		−2%	0%
MH-MSEDCL	20%	8%	36%	31%	6%	0%	−34%	−4%	48%	−6%	1%
MH-RInfra-D	50%	35%	11%	0%	4%	0%	−2%	0%	3%	0%	−1%
MH-TPC-D	44%	25%	23%	0%	8%	17%	−9%	−4%		−3%	1%
MN-MSPDCL	63%	9%	5%	0%	23%	87%	34%	89%	149%	61%	75%
MP-MP-Central	32%	7%	19%	35%	7%	0%	−14%	−2%	0%	−4%	−2%
MP-MP-East	34%	7%	15%	37%	6%	0%	−10%	−5%	0%	−3%	−2%
MP-MP-West	21%	6%	19%	48%	7%	0%	−16%	−5%		−4%	−3%
MR-P&ED-M	49%	7%	2%	0%	41%	71%	17%	29%	224%	118%	80%
NL-DPN	52%	16%	10%	0%	23%	135%	51%	80%	160%	76%	97%
OR-CESU	50%	19%	17%	3%	11%	1%	−13%	−11%	55%	−7%	−5%
OR-NESCO	39%	9%	39%	4%	10%	11%	−10%	−2%	119%	−6%	2%
OR-SOUTHCO	60%	10%	17%	4%	9%	0%	−30%	−15%	95%	−22%	−9%
OR-WESCO	38%	8%	41%	4%	9%	0%	−16%	−11%	121%	−9%	−7%
PB-PSPCL	30%	9%	34%	24%	3%	0%	−8%	−2%	0%	−3%	−2%
PD-EDP	30%	9%	55%	2%	3%	76%	0%	−1%	1144%	−10%	12%
RJ-AVVNL	23%	8%	28%	35%	5%	0%	−13%	−1%	16%	0%	2%
RJ-JdVVNL	20%	7%	12%	53%	7%	0%	−13%	−2%	13%	0%	4%
RJ-JVVNL	25%	11%	29%	31%	5%	0%	−13%	0%	14%	0%	1%
TG-TSNPDCL	21%	4%	11%	52%	12%	0%	−23%	−4%	0%	0%	−2%
TG-TSSPDCL	25%	7%	28%	30%	11%	0%	−29%	−11%	115%	−23%	2%
TN-TANGEDCO	33%	14%	31%	14%	8%	32%	−22%	−11%	62%	−12%	0%
UK-UPCL	25%	11%	54%	4%	6%	0%	0%	0%	53%	0%	1%
UP-DVVNL	36%	5%	15%	25%	20%	1%	0%	−4%	26%	6%	6%
UP-KESCO	48%	11%	27%	0%	15%	−3%	−46%	−16%		−43%	−21%
UP-MVVNL	50%	7%	12%	17%	14%	7%	−21%	0%	39%	−7%	4%
UP-PuVVNL	53%	9%	8%	21%	9%	18%	−14%	−4%	48%	−10%	11%
UP-PVVNL	41%	5%	21%	22%	11%	0%	−38%	−10%	110%	−28%	−2%
WB-CESC	46%	19%	23%	0%	12%	0%	0%	0%		0%	0%
WB-WBSEDCL	39%	13%	31%	5%	11%	0%	0%	0%	25%	−1%	1%
JH-DVC	0%	0%	93%	0%	7%	0%	0%	0%		0%	0%

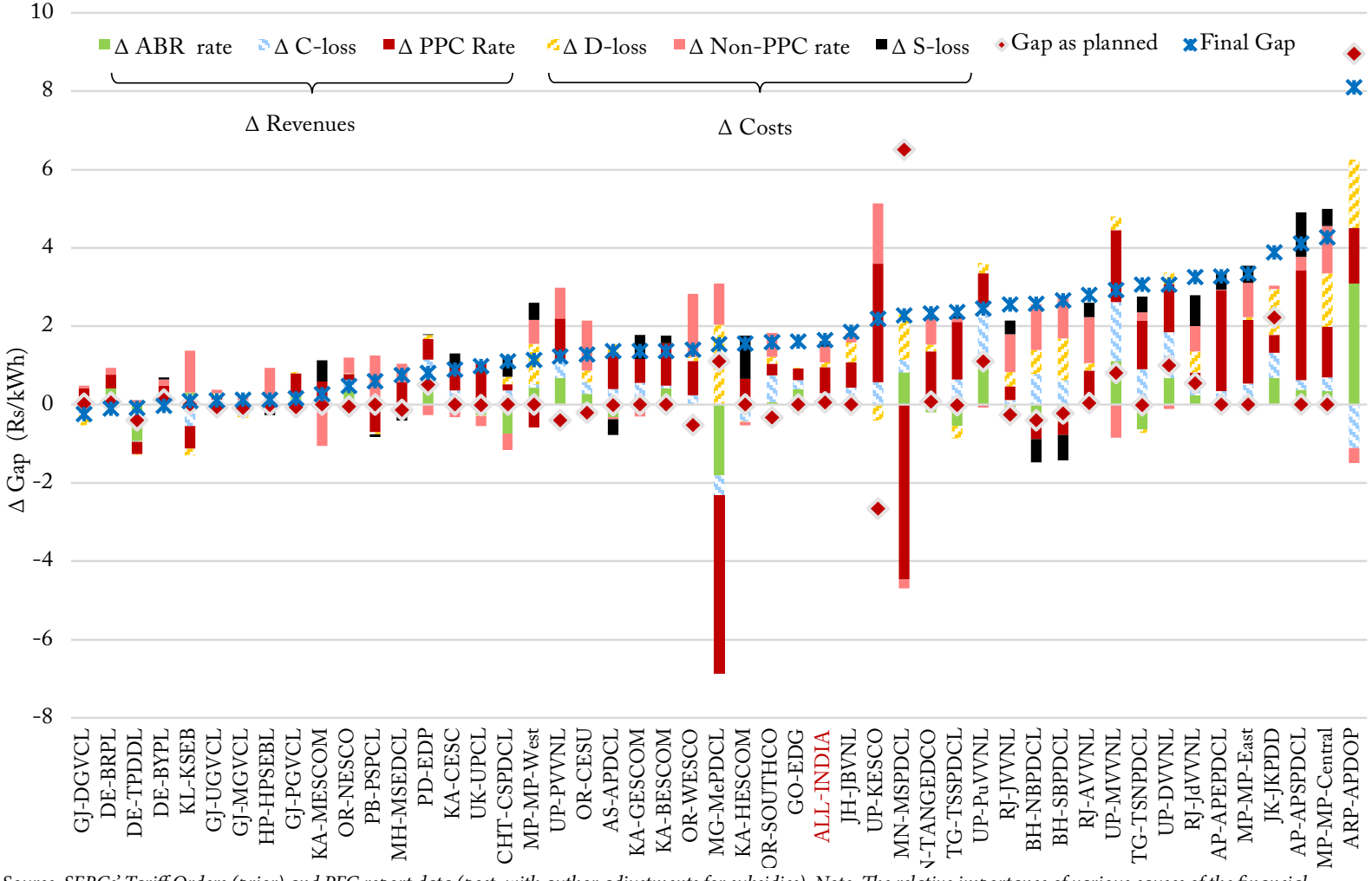
Source: Authors' analysis

Notes: Revenues from other operations like network access are not part of these values, and would add a few paise of revenues (thus, ABR from sale of power could be a few paise below ACoS). This is for tariff rise/fall illustration only, based on the ABR for the consumer category.

Appendix B: DisCom-wise Implications

Appendix B1: DisCom-wise Details on the *Ex-Post* Financial Gap and its Causes

Figure 24: DisCom-wise *Ex-ante* to *Ex-post* ACoS-ARR Gap Change Across DisComs (FY19) by Component



Source: SERCs' Tariff Orders (prior) and PFC report data (post, with author adjustments for subsidies). Note: The relative importance of various causes of the financial gap varies by DisCom. The striped components ΔC and ΔD are the ones under direct DisCom control. Because the deviations are calculated on per unit sold basis, and volumes can change dramatically between planned and post, one cannot simply add the Δs at the component level to arrive at the aggregate change between planned and post gap. This is why an outlier state in the North-East (Meghalaya) has a negative shift for PPC per unit sold, but still a net worsening of the gap. See text for more details.

Table 14: DisCom-wise Deltas (Δ) in D- and C-Losses (Rs crore), Bifurcated by Operational Performance (FY19)

DisCom	*Ex-ante* gap (cost minus revenue) (Rs crore)	Excess distribution network loss (Rs crore) (negative means improvement)	Excess consumer collection loss (Rs crore)	Non-DisComs loss (Rs crore)		*Ex-post* gap (cost minus revenue) (Rs crore)
				Subsidy unpaid (Rs crore)	Other operational loss (Rs crore)	
Group 1: DisCom performed better than targeted distribution loss						
TG-TSSPDCL	(42)	(1,367)	2,803	248	8,167	9,808
GJ-DGVCL	34	(519)	(504)	0	678	(311)
KL-KSEB	22	(393)	(1,218)	0	1,017	(572)
AP-APSPDCL	(0)	(217)	880	3,914	9,732	14,308
PB-PSPCL	18	(184)	373	(400)	2,213	2,020
TG-TSNPDCL	(35)	(184)	1,670	753	3,416	5,621
AP-APEPDCL	0	(169)	546	888	5,044	6,309
GJ-MGVCL	(82)	(137)	28	0	327	136
UP-KESCO	(904)	(117)	179	0	1,534	692
DE-BRPL	(106)	(116)	8	(24)	139	(98)
DE-BYPL	(68)	(96)	1	36	114	(13)
UP-PVVNL	(1,365)	(63)	1,396	0	3,513	3,481
UK-UPCL	(9)	(39)	176	0	1,114	1,242
HP-HPSEBL	(6)	(31)	(37)	(129)	420	217
KA-GESCOM	(2)	(24)	284	461	160	878
MH-MSEDCL	(1,425)	(20)	546	(1,316)	11,431	9,216
KA-HESCOM	(2)	(19)	(341)	1,292	782	1,712
KA-CESC	(1)	(19)	108	238	161	486
DE-TPDDL	(314)	(17)	(20)	0	286	(66)
KA-MESCOM	(1)	(9)	16	266	(214)	57

Group 2: DisCom performed worse than targeted distribution loss						
KA-BESCOM	(1)	4	197	538	2,479	3,217
GO-EDG	1	8	85	0	196	290
OR-NESCO	(22)	9	115	0	122	224
PD-EDP	132	30	128	4	(97)	196
OR-SOUTHCO	(100)	42	174	0	290	407
OR-WESCO	(275)	58	131	0	1,177	1,091
ARP-APDOP	380	80	(50)	0	(63)	346
GJ-PGVCL	(154)	87	143	0	411	487
MN-MSPDCL	365	90	24	0	(311)	168
MP-MP-East	(7)	93	588	645	3,681	5,000
AS-APDCL	(7)	151	302	(290)	892	1,048
GJ-UGVCL	(147)	170	109	0	138	270
OR-CESU	(144)	185	189	0	573	802
RJ-AVVNL	54	341	97	654	3,329	4,476
MG-MePDCL	112	355	(90)	0	(108)	269
JH-JBVNL	(2)	470	404	0	926	1,797
CHT-CSPDCL	5	532	993	1,485	190	3,205
UP-PuVVNL	2,758	548	2,683	0	(877)	5,113
BH-NBPDCL	(352)	584	743	(566)	1,553	1,962
UP-DVVNL	2,162	585	2,213	0	886	5,845
UP-MVVNL	1,715	603	2,494	0	62	4,873
RJ-JVVNL	(610)	922	297	870	4,294	5,774
JK-JKPDD	2,205	1,102	611	0	(268)	3,650
RJ-JdVVNL	1,131	1,114	348	1,607	2,046	6,247
BH-SBPDCL	(269)	1,121	664	(680)	1,581	2,416
TN-TANGEDCO	(99)	1,223	1,271	31	14,384	16,810
MP-MP-Central	4	2,051	514	665	3,212	6,446
MP-MP-West	(4)	2,128	201	921	(874)	2,372
DisCom performed better than targeted Distribution network loss	(4,288)	(3,741)	6,891	6,227	50,034	55,124
DisCom performed worse than targeted Distribution network loss	8,830	14,686	15,577	5,884	39,823	84,800
All-India	4,542	10,945	22,469	12,111	89,857	1,39,924

Note: Other losses include higher costs due to power procurement and other factors.

Appendix B2: DisCom-wise Approach for Tariff Hike

Box 3: Consistent but Distinct Approaches Required for Each DisCom

A mix of actions can, or need to, be undertaken. We break up the tariff changes across DisComs and then consider how much of a rise would be required where. We focus on *ex-ante* tariffs in this analysis, to focus on heterogeneity and regulatory outcomes of tariff-setting. Thus, improvements in AT&C losses to match targets aren't relevant, since they only affect the *ex-post* financials.

We approach segmentation by first bucketing DisComs by the net revenue impact of compliance. Haryana's Daksin Haryana Bijli Vitran Nigam (DHBVN), Himachal Pradesh's State Electricity Board Limited (HPSEBL), and West Bengal's Calcutta Electric Supply Corporation Limited (WB-CESC) are within ±20% cross-subsidy limits across all categories.

For the remaining 57 DisComs, we split them up into categories at two levels, starting with the first split based on whether compliance would raise or lower overall revenues (Figure 25). We then add in a layer based on additional criteria such as the required tariff rise level, share of units impacted, and historical ABR rises over the last three years. Details on these are broken down in Table 15 in Appendix B2.

For the N group where there will be a negative impact on net revenues after complying, this means there is more reduction from overpayers than rise in tariffs for underpayers. While this could mean minimal tariff rises for compliance, for some DisComs this is not the case. In N3, there are a mix of overpayers and underpayers.

For all the N group cases, because there is a net revenue decline, the only way for total DisCom revenues to match costs is if tariffs go up elsewhere. But because overpayers cannot go back up beyond the threshold, this means the partially over-payers (100-120% of ACoS) as well as the underpayers would need a rise in tariff. Which sub-group of consumers sees how much change is a complex issue.

For the P group of DisComs (those with a net-positive impact of compliance), there would not need to be any further increases required to keep DisCom revenues matching costs as projected. In fact, because this is net-positive for the DisCom, they could slightly lower tariffs elsewhere. Of course, this only happens if there is a greater rise from underpayers than decline for overpayers.

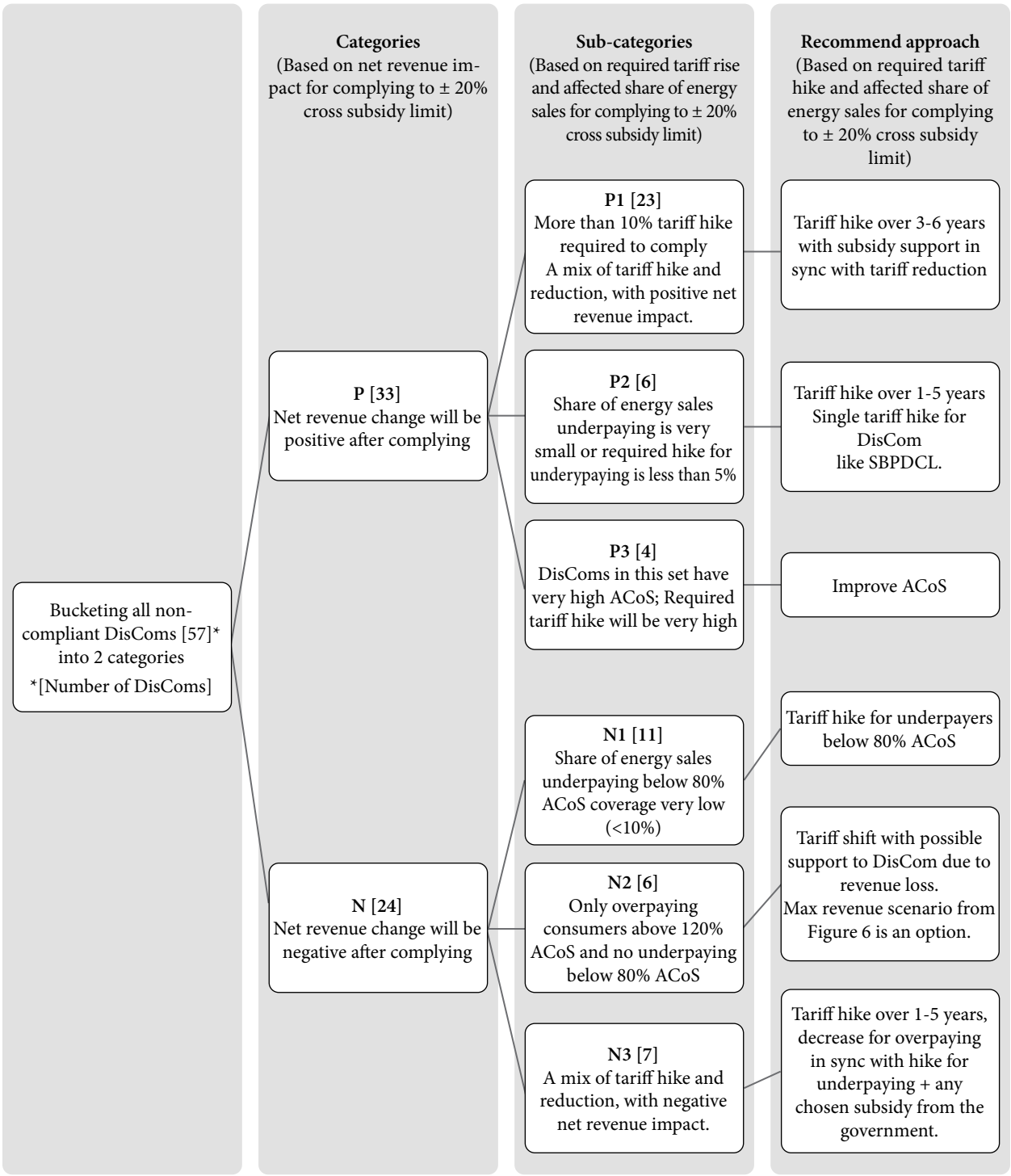
As the figure shows, some sub-categories are easy, but in some the required tariff hike is more than can reasonably be spread out over a few years. In such a case, the state may need to chip in with separate subsidy support or find other sources of funds.

For each DisCom, we examine the share of total supply that is out of compliance with the ±20% cross-subsidy limit, and also quantify how much the tariffs need to shift (Table 15 in Appendix B2). Based on these, we calculate the net change in revenue, which splits up DisComs into positive (P) and negative (N) net revenues. We also show the historical ABR change for the previous three years, to give a sense of whether required tariff rises are similar in scale, which further helps split DisComs into sub-categories. In each bucket, the units' share that is out of compliance is shown visually, both for underpayers (below 80% of ACoS) and overpayers (above 120% of ACoS). The ACoS is listed for reference purposes.

These are grouped based on net revenue impact matching Figure 25, starting with P (positive revenue) groups and then with N (negative revenue) groups; the last column shows the respective sub-groups.

The calculations shown in Appendix B2 are based on *ex-ante*, and if we consider *ex-post* realities, the challenge is even greater since average costs have shifted higher. Given each year will vary, and the numbers would have shifted significantly because of COVID-19, we reiterate that the above analysis should be viewed as illustrative, instead of specific numbers for individual DisComs.

Figure 25: DisCom Categories for Cross-subsidy Compliance and Revenue Recovery – FY19 Basis Illustration



Source: Authors' analysis.

Note: The number in the bracket is the number of DisComs in each category or sub-category.

Table 15: DisCom-wise Tariff Change based on Underpayer and Overpayer for Cross-subsidy Gap Coverage

DISCOMs	ACoS (Rs/kWh)	DisCOm ABR (Rs/kWh)	Present ABR (Rs./kWh)		Required ABR to comply (Rs./kWh)		ABR <80% of ACoS		ABR >120% of ACoS		Net revenue change (Rs/kWh)	Net revenue impact	Average tariff change (%)	Resultant Sub-Category
			<80% of ACoS	>120% of ACoS	<80% of ACoS	>120 % of ACoS	Units share	Tariff change (%)	Units share	Tariff change (%)				
AP-APEPDCL	5.85	5.71	3.67	10.18	4.68	7.02	27%		-31%		0.12	0.0%	3.5%	P1
DD-ED-DD	4.60	3.99	2.62	0	3.68	0	40%		-		0.18	0.0%	NA	P1
GO-EDG	5.36	4.45	2.85	7.12	4.29	6.43	50%		-10%		0.46	0.0%	NA	P1
GJ-PGVCL	5.55	5.63	3.47	7.21	4.44	6.66	28%		-8%		0.06	0.0%	7.4%	P1
GJ-MGVCL	6.18	6.30	3.16	7.70	4.94	7.42	56%		-4%		0.18	0.0%	5.2%	P1
HR-UHBVN	7.97	7.31	5.14	9.59	6.38	9.56	24%		0%		0.30	0.0%	-3.0%	P1
JK-JKPDD	5.84	3.10	3.00	9.32	4.67	7.01	56%		-25%		1.61	0.1%	3.5%	P1
KA-BESCOM	6.80	6.54	3.70	8.84	5.44	8.16	47%		-8%		0.20	0.0%	4.9%	P1
KL-KSEB	6.11	5.67	4.08	9.25	4.89	7.33	20%		-21%		0.16	0.0%	2.1%	P1
MH-MSEDCL	6.67	6.78	3.60	9.15	5.34	8.00	48%		-12%		0.12	0.0%	9.0%	P1
MH-TPC-D	7.39	7.29	5.05	9.69	5.91	8.87	17%		-8%		0.08	0.0%	NA	P1
MG-MePDCL	7.65	6.44	5.13	0	6.12	0	19%		-		0.49	0.1%	4.9%	P1
OR-NESCO	4.78	4.68	3.30	6.35	3.82	5.74	16%		-10%		0.14	0.0%	1.3%	P1
RJ-JVVNL	6.99	6.96	4.90	9.61	5.59	8.39	14%		-13%		0.08	0.0%	-0.4%	P1
RJ-AVVNL	7.19	6.88	4.96	9.01	5.75	8.63	16%		-4%		0.18	0.0%	3.1%	P1
RJ-JdVVNL	6.97	6.13	4.92	9.07	5.58	8.36	13%		-8%		0.27	0.0%	2.3%	P1
TG-TSSPDCL	5.90	5.42	1.43	8.48	4.72	7.08	231%		-16%		0.39	0.0%	4.1%	P1
TN-TANGEDCO	5.84	5.68	3.34	8.65	4.67	7.01	40%		-19%		0.10	0.0%	-4.0%	P1
UP-DVVNL	6.69	5.56	4.77	8.91	5.35	8.03	12%		-10%		0.34	0%	7.7%	P1
UP-PVVNL	5.21	5.23	1.55	7.56	4.17	6.25	168%		-17%		0.17	0%	NA	P1
UP-MVVNL	6.98	5.77	4.73	10.58	5.58	8.38	18%		-21%		0.40	0%	10.0%	P1
UP-PuVVNL	6.46	5.04	3.88	8.65	5.17	7.75	33%		-10%		0.77	0%	10.5%	P1
PD-EDP	5.28	4.72	2.27	7.47	4.22	6.34	86%		-15%		0.62	0%	NA	P1
BH-SBPDCL	7.49	7.33	5.88	0	5.99	0	2%		-		0.01	0%	5.4%	P2
DNH-DNHPDCL	4.92	4.26	3.23	0	3.94	0	22%		-		0.05	0%	14.2%	P2
GJ-DGVCL	6.63	6.63	3.73	0	5.30	0	42%		-		0.08	0%	3.5%	P2
UK-UPCL	5.05	5.05	1.84	0	4.04	0	120%		-		0.07	0%	4.3%	P2
WB-WBSEDCL	7.22	6.94	4.62	0	5.78	0	25%		-		0.07	0%	0.1%	P2
PB-PSPCL	6.56	6.39	5.16	0	5.25	0	2%		-		0.02	0%	5.5%	P2
ARP-APDOP	13.32	3.85	3.85	0	10.66	0	176%		-		6.80	5%	NA	P3
MN-MSPDCL	12.00	5.34	5.34	0	9.60	0	80%		-		4.26	2%	-6.4%	P3
MR-P&ED-M	8.90	4.45	4.45	0	7.12	0	60%		-		2.67	2%	NA	P3
NL-DPN	12.98	5.09	5.09	0	10.38	0	104%		-		5.29	2%	NA	P3
AP-APSPDCL	5.90	6.69	4.14	7.93	4.72	7.08		14%		-11%	(0.34)	0.0%	-1.0%	N1
CH-CED	5.16	5.15	2.89	6.26	4.13	6.19		43%		-1%	(0.03)	0.0%	NA	N1
DE-BRPL	7.47	7.57	3.26	10.58	5.98	8.96		84%		-15%	(0.54)	0.0%	0.6%	N1
JH-JBVNL	5.86	5.85	3.20	8.24	4.69	7.03		46%		-15%	(0.29)	0.0%	-1.9%	N1
KA-HESCOM	6.80	6.70	2.64	9.10	5.44	8.16		106%		-10%	(0.08)	0.0%	4.7%	N1
KA-GESCOM	6.74	6.55	2.84	8.69	5.39	8.09		90%		-7%	(0.10)	0.0%	4.4%	N1
KA-CESC	6.37	6.17	2.51	8.48	5.10	7.64		103%		-10%	(0.16)	0.0%	0.7%	N1
MH-BEST	7.10	6.99	2.57	8.61	5.68	8.52		121%		-1%	(0.01)	0.0%	1.8%	N1
MH-RInfra-D	8.60	8.58	5.71	10.99	6.88	10.32		20%		-6%	(0.06)	0.0%	-0.2%	N1
OR-SOUTHCO	4.30	4.43	1.77	6.54	3.44	5.16		95%		-21%	(0.33)	0.0%	NA	N1
OR-WESCO	4.70	5.14	1.70	6.43	3.76	5.64		121%		-12%	(0.33)	0.0%	2.5%	N1
TG-TSNPDCL	6.29	6.39	0	9.66	0	7.55		-		-22%	(0.14)	0.0%	1.8%	N2
BH-NBPDCL	7.18	7.15	0	8.74	0	8.62		-		-1%	(0.02)	0.0%	5.2%	N2
MP-MP-East	6.00	5.99	0	7.71	0	7.20		-		-7%	(0.12)	0.0%	NA	N2
MP-MP-West	6.02	5.97	0	7.93	0	7.22		-		-9%	(0.15)	0.0%	NA	N2
MP-MP-Central	6.08	6.03	0	8.44	0	7.30		-		-14%	(0.11)	0.0%	NA	N2
UP-KESCO	5.11	7.27	0	7.27	0	6.13		-		-16%	(1.14)	-0.1%	-0.2%	N2
DE-TPDDL	7.34	7.74	5.45	10.15	5.87	8.81		8%		-13%	(0.44)	0.0%	9.4%	N3

DISCOMs	ACoS (Rs/kWh)	DisCOm ABR (Rs/kWh)	Present ABR (Rs./kWh)		Required ABR to comply (Rs./kWh)		ABR <80% of ACoS		ABR >120% of ACoS		Net revenue change (Rs/kWh)	Net revenue impact	Average tariff change (%)	Resultant Sub-Category
			<80% of ACoS	>120% of ACoS	<80% of ACoS	>120 % of ACoS	Units share	Tariff change (%)	Units share	Tariff change (%)				
AS-APDCL	7.35	7.23	5.34	9.36	5.88	8.82		10.1%		-6%	(0.04)	0.0%	1.0%	N3
CHT-CSPDCL	6.20	6.21	4.66	8.25	4.96	7.44		6%		-10%	(0.08)	0.0%	1.5%	N3
DE-BYPL	7.41	7.62	5.84	10.77	5.93	8.89		2%		-17%	(0.62)	0.0%	-1.4%	N3
GJ-UGVCL	5.13	5.20	3.37	7.83	4.10	6.16		22%		-21%	(0.20)	0.0%	7.8%	N3
KA-MESCOM	6.86	6.68	5.27	9.43	5.49	8.23		4%		-13%	(0.09)	0.0%	4.4%	N3
OR-CESU	4.73	4.81	3.65	6.45	3.78	5.68		4%		-12%	(0.24)	0.0%	-0.5%	N3
HR-DHBVN	6.51	6.17	0	0	0	0		-	0%	-	0	0%	-4.3%	Compliant
HP-HPSEBL	5.59	5.56	0	0	0	0		-	0%	-	0	0%	0.0%	Compliant
JH-DVC	4.76	4.26	0	0	0	0		-	0%	-	0	0%	0.0%	Compliant
WB-CESC	7.02	7.24	0	0	0	0		-	0%	-	0	0%	0.0%	Compliant

Source: Author's analysis.

Note: The ABRs shown are for the buckets of units per band, e.g., those that are below 80% or above 120% of ACoS.

The horizontal bars show the share of units that are in violation (below or above the cross-subsidy limits), in grey and red, respectively. The last column matches the categories of DisComs as per Figure 23.

Table 16: JBVNL Meter Status Report (FY18 and FY19)

Total Consumers	Metered -Working	Metered - Not Working	Unmetered
3,114,556	871,473	100,009	2,143,074

Source: Tariff Petitions by JBVNL (n.d.).

Appendix C: Abbreviations

Appendix C1: List of States

AP	Andhra Pradesh
ARP	Arunachal Pradesh
AS	Assam
BH	Bihar
CH	Chandigarh
CHT	Chhattisgarh
DD	Daman and Diu
DE	Delhi
DNH	Dadar and Nagar Haveli
GJ	Gujarat
GO	Goa
HP	Himachal Pradesh
HR	Haryana
JH	Jharkhand
JK	Jammu and Kashmir
KA	Karnataka
KL	Kerala
MG	Meghalaya
MH	Maharashtra
MN	Manipur
MP	Madhya Pradesh
MR	Mizoram
NL	Nagaland
OR	Odisha
PB	Punjab
PD	Pondicherry
RJ	Rajasthan
TG	Telangana
TN	Tamil Nadu
UK	Uttarakhand
UP	Uttar Pradesh
WB	West Bengal

Appendix C2: List of DisComs

APDCL	Assam Power Distribution Company Limited
APDOP	Arunachal Pradesh Department of Power
APEPDCL	Eastern Power Distribution Company of Andhra Pradesh Limited
APSPDCL	Southern Power Distribution Company of Andhra Pradesh Limited
AVVNL	Ajmer Vidyut Vitran Nigam Limited
BESCOM	Bangalore Electricity Supply Company Limited
BEST	Brihanmumbai Electric Supply and Transport Undertaking
BRPL	BSES Rajdhani Power Limited
BYPL	BSES Yamuna Power Limited
CED	Chandigarh Electricity Distribution
CESC	Calcutta Electric Supply Corporation Limited
CESCOM	Chamundeshwari Electricity Supply Corporation Limited
CESU	Central Electricity Supply Utility of Odisha
CSPDCL	Chhattisgarh State Power Distribution Company Limited
DGVCL	Dakshin Gujarat Vij Company Limited
DHBVN	Dakshin Haryana Bijli Vitran Nigam
DNHPDCL	DNH Power Distribution Corporation Limited
DPN	Department of Power Nagaland
DVVNL	Dakshinanchal Vidyut Vitran Nigam Limited
ED-DD	Department of Power Daman and Diu
EDG	Goa Electricity Department
EDP	Electricity Department Pondicherry
GESCOM	Gulbarga Electricity Supply Company Limited
HESCOM	Hubli Electricity Supply Company Limited
HPSEBL	Himachal Pradesh State Electricity Board Limited
JBVNL	Jharkhand Bijli Vitran Nigam Limited
JDVVNL	Jodhpur Vidyut Vitran Nigam Limited
JKPDD	Power Development Department, Jammu and Kashmir
JVVNL	Jaipur Vidyut Vitran Nigam Limited
KESCO	Kanpur Electricity Supply Company Limited
KSEB	Kerala State Electricity Board Limited
MEPDCL	Meghalaya Power Distribution Corporation Limited
MESCOM	Mangalore Electricity Supply Company Limited
MGVCL	Madhya Gujarat Vij Company Limited
MP Central	Madhya Pradesh Madhya Kshetra Vidyut Vitaran Company Limited
MP East	Madhya Pradesh Poorv Kshetra Vidyut Vitaran Company Limited

MP West	Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Limited
MSEDCL	Maharashtra State Electricity Distribution Company Limited
MSPDCL	Manipur State Power Distribution Company Limited
MVVNL	Madhyanchal Vidyut Vitran Nigam Limited
NBPDCL	North Bihar Power Distribution Company Limited
NESCO	North Eastern Electricity Supply Company of Odisha Limited
P&ED-M	Power & Electricity Department, Mizoram
PGVCL	Paschim Gujarat Vij Company Limited
PSPCL	Punjab State Power Corporation Limited
PuVVNL	Purvanchal Vidyut Vitaran Nigam Limited
PVVNL	Pashchimanchal Vidyut Vitran Nigam Limited
R Infra D	Reliance Infrastructure Limited (Distribution Business)
SBPDCL	South Bihar Power Distribution Company Limited
SOUTHCO	SOUTHCO Utility, Odisha
TANGEDCO	Tamil Nadu Generation and Distribution Corporation
TPC-D	Tata Power Company Limited (Distribution)
TPDDL	Tata Power Delhi Distribution Limited
TSNPDCL	Telangana State Northern Power Distribution Company Limited
TSSPDCL	Telangana State Southern Power Distribution Company Limited
UGVCL	Uttar Gujarat Vij Company Limited
UHBVN	Uttar Haryana Bijli Vitran Nigam
UPCL	Uttarakhand Power Corporation Limited
WBSEDCL	West Bengal State Electricity Distribution Company Limited
WESCO	Western Electricity Supply Company of Odisha

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