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# DisCom Billing Losses

## Moderate Improvements, but Miles to go

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Designed by Umesh Kumar

# DisCom Billing Losses

## Moderate Improvements, but Miles to go

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# Abbreviations

| | |
|---|---|
| **ABC** | Aerial Bunched Cables |
| **ACS (or) ACoS** | Average Cost of Supply |
| **AMI** | Advanced Metering Infrastructure |
| **APDP** | Accelerated Power Development Programme |
| **APDRP** | Accelerated Power Development Reforms Programme |
| **APEPDCL** | Andhra Pradesh Eastern Power Distribution Company Limited |
| **APPC** | Average Power Purchase Cost / Average Power Procurement Cost |
| **ARR** | Annual Revenue Recovery |
| **AT&C** | Aggregate Technical and Commercial |
| **BEST** | Brihanmumbai Electricity Supply &Transport Undertaking |
| **CAG** | Comptroller and Auditor General of India |
| **Capex** | Capital Expenditure |
| **CEA** | Central Electricity Authority |
| **CERC** | Central Electricity Regulatory Commission |
| **CGS** | Central Government Scheme |
| **Cr. (or) cr.** | Crore |
| **DDUGJY** | Deen Dayal Upadhyaya Gram Jyoti Yojana |
| **DisCom** | Distribution Company / Distribution Utility |
| **DGVCL** | Dakshin Gujarat Vij Company Limited |
| **DT** | Distribution Transformer |
| **EBR** | Extra Budgetary Resources |
| **ERP** | Enterprise Resource Planning |
| **EV** | Electric Vehicle |
| **FoR** | Forum of Regulators |
| **FY** | Financial Year |
| **GBS** | Gross Budgetary Support |
| **GIS** | Gas Insulated Switchgear |
| **HT** | High Tension |
| **IR** | Improvement Rate / Rate of Improvement |
| **IT** | Information Technology |
| **IPDS** | Integrated Power Development Scheme |
| **JERC** | Joint Electricity Regulatory Commission |
| **KSEBL** | Kerala State Electricity Board Limited |
| **kV** | kilo Volt |
| **kWh** | kilo Watt hour |
| **LT** | Low Tension |
| **MoP** | Ministry of Power |
| **OT** | Operational Technology |
| **PFC** | Power Finance Corporation |
| **PIB** | Press Information Bureau |
| **PPA** | Power Purchase Agreement |
| **R-APDRP** | Restructured Accelerated Power Development Reforms Programme |

| | |
|---|---|
| **RDSS** | Revamped Distribution Sector Scheme |
| **REC** | Rural Electrification Corporation |
| **RGGVY** | Rajiv Gandhi Gramin Vidyutikaran Yojana |
| **R&M** | Repair and Maintenance |
| **Rs** | Rupees |
| **RT-DAS** | Real Time – Data Acquisition System |
| **RTS** | Roof Top Solar |
| **SAUBHAGYA** | Pradhan Mantri Sahaj Bijli Har Ghar Yojana |
| **SCADA** | Supervisory Control and Data Acquisition |
| **SCE** | Standing Committee on Energy |
| **SERC** | State Electricity Regulatory Commission |
| **UDAY** | Ujwal Discom Assurance Yojana |

# Executive Summary

Aggregate Technical and Commercial losses (AT&C losses) have consistently remained a major problem in the distribution space of the electricity sector in India. AT&C losses are a widely discussed issue, with conventional wisdom blaming high AT&C losses as the root cause of Distribution Company (DisCom) financial problems. However, recent trends show improved AT&C losses. In this paper we examine the losses in detail, breaking the composite AT&C loss figures into constituents to understand if these improvements are sustainable and address the financial problems of DisComs.

A high AT&C loss does not inherently mean financial losses for the DisCom—the impact depends on the target set by the regulator. Regulators allow a certain level of AT&C losses, and these costs are passed through to consumers. However, the excess losses (i.e., beyond the specified mark) incurred by the DisComs pose the real threat. Although the AT&C losses have improved from a high of 30.47% (in FY2007) to 15.79% (in FY2023), in financial terms they are still high, more so when we multiply percentage per unit losses by the rising volume and higher prices.

Even at the improved level of 15.79% (2023), the *excess* AT&C loss costs around Rs 0.21 per each unit of energy (kilowatt-hours or kWh) sold by the DisComs. The same excess AT&C losses, cumulatively over a period of 17 years (FY2007–FY2023), constituted over one-third of the total cash basis financial gap suffered by all public sector DisComs put together. Therefore, the improvement observed in AT&C loss in percentage terms is not a reason to feel relieved. To address the problem of financial gap suffered by public sector DisComs, AT&C loss is an urgent issue that needs to be tackled upfront.

Digging into its constituents, AT&C loss comprises of two components: technical loss (also called billing loss) and collection loss. Billing loss is the amount of energy (in kWh) lost in the network, i.e., from the point of input at the DisCom periphery to the delivery point of the end-consumer. Billing loss happens due to network physical losses as well as theft of electricity. Theft includes stealing electricity by laying bare hooks onto the transmission conductors, withdrawal of energy by an un-registered consumer from distribution lines and poles, meter tampering etc.

In contrast, the collection loss indicates loss due to DisComs' inability to collect money against the bills raised to the consumers and is measured in rupees. Collection loss also includes loss due to drawl of electricity under the subsidised consumer category–but using it for commercial purposes, etc. Collection losses span both types of non-payments–by the end-consumer and the state government in case it had promised a subsidy. However, collection loss also includes another form of theft such as unauthorised use of electricity (using a domestic connection for commercial purposes), drawl through tampered meters etc.

## Is Steady Improvement of AT&C Losses Good Enough?

Since FY2007, both the components of AT&C loss have been improving in percentage terms. While the billing losses have improved from a whopping 26.2% (in FY2007) to 13.28% (in FY2023), the collection losses improved from 5.83% to 2.89%. Irrespective of the improvement in percentage terms, it is the 'excess losses' beyond the mark specified by the regulator and its impact in financial terms that matters most.

This improvement in billing losses can be seen where the FY2023 loss was observed to be Rs 4,730 crore, while the cumulative billing loss (FY2007-FY2023) beyond the normative target was Rs 74,766 crore.

Although the gap between normative billing loss and the billing loss achieved substantially reduced over the period, still there exists significant scope for further correction of the current normative mark of billing loss from 12.58% to around 4%.[1] More than ten public sector DisComs have already achieved less than 10% billing loss, and this is good enough signal for regulators of other DisComs to bring down the normative mark much further. Putting it all together, there is enough scope for billing losses to come down from the current level of 13.28%.

[1] This suggested normative mark is the average billing loss of top-five public sector distribution utilities (including Power Departments) in terms of their billing loss achieved during FY2022-2023, i.e., Goa Power Department (0.93%), Dakshin Gujarat Vij Company Limited-DGVCL (1.63%), Brihanmumbai Electricity Supply & Transport Undertaking-BEST (4.18%), Andhra Pradesh Eastern Power Distribution Company Limited-APEPDCL (5.94%), and Kerala State Electricity Board Limited-KSEBL (6.87%). Note that not all of these are urban. A simple average billing loss of these five utilities comes to around 3.91%.

Bringing down the billing losses helps bridge the financial gap that distribution sector is currently suffering from. At the current power purchase costs, assuming DisComs achieve a moderate target of close to 6%, the financial value of this 7.28% of billing loss reduction can bring down the DisCom's power purchase cost by around Rs 33,000 crore every year, from FY2030 onwards (at the current power puchase prices). Given the escalation in power procurement costs over the period, if the billing loss is not improved, the loss in rupee terms is likely to increase further. As such, it is needless to say that any reduction in DisComs' expenditure brings down the tariff burden on the consumer.

In this context, this paper focuses its analysis on billing losses and the way forward for its improvement.

## Critical Issues That Helped Loss Improvement

What is the path forward to reduce losses further? This paper is aimed at addressing a range of questions for public utilities across India:

1. Given the billing loss improvement achieved since FY2007, what is the level of investment (or channels of revenue) that facilitated such improvement?
2. What have been the roles of Government (through schemes) as well as the Distribution Companies (DisComs) (through capital expenditure and repairs and maintenance) in facilitating such improvement?
3. How do investments through 'repairs and maintenance' and 'capital expenditure' complement each other?
4. Can the efficacy of investment be measured? If not, what are the challenges?
5. Regarding DisComs, is there any saturation effect between high and low loss areas? Stated another way, where would we expect the maximum bang-for-buck improvement?
6. What does it take to achieve the ultimate goal of matching the best figures achieved by a public DisCom?
7. What are the policy implications based on the inevitable heterogeneity across and within DisComs?

## Challenges in Measuring Efficiency of Investments

Progressively tighter targets for billing losses require a combination of steps by DisComs; some are based on intangibles (including political will), but many loss reductions require investments in grid strengthening, IT infrastructure, manpower, etc. Another challenge is the ongoing evolution of the grid, which is growing in reach, changing consumer mix, change in demand, among other factors.

Measuring billing losses and the efficacy of investments made is complex for two main reasons. Firstly, the data on billing efficiency are never 100% accurate because of the lack of universal metering (and meter reading). The overwhelming majority of agricultural consumption is unmetered, and its accounting is heavily assumption-based. Historically, there was a wider lack of metering across a large chunk of consumers, and so some older data are also questionable. Secondly, measurement of investments made, and its efficacy is also quite challenging.

Given DisComs are cash-strapped, there is a greater reliance on many Central Government schemes for capital expenditures, some of them explicitly geared towards loss reduction (e.g., Restructured Accelerated Power Development & Reforms Programme (R-APDRP)). Even for other investments like the Rajiv Gandhi Gramin Vidyutikaran Yojana (RGGVY) scheme for rural electrification, the investment went not just for new wires but also for increasing the capacity of existing rural networks, which ultimately facilitates lowering billing losses.

Most of the investments being dual or multi-purpose, breaking down the investment into identifiable components that directly improve billing losses is challenging. At the same time, it remains to be seen if well-accepted regression techniques provide any insights.

## The Way Forward

Given the criticality of the objectives and the challenges as explained above, this paper therefore, makes recommendations on the following lines:

1. Regulators should consider a tightened billing loss improvement trajectory to bring down losses from the current 13.28% to reach the benchmark 6%, i.e. 7.28% improvement over a seven-year period (they could consider a lesser range as well, depending on a host of factors including consumer mix, geographic terrain etc.).

2. Given the track record of past investments, there is a requirement for greater Central Government allocations and capital expenditure as well as 'repairs & maintenance' expenditure by the DisComs.

3. Owing to the criticality of government support through multi-objective schemes in improving networks, the schemes should be designed for a longer duration, while customising the terms and conditions to meet the heterogeneous nature of DisComs which also have varying loss levels.

4. As measurement of losses suffers from inherent challenges, distribution transformer (DT)-level and feeder-level (in that order) metering should be taken up as a priority.

5. Loss due to theft is part of billing losses, and it can be safely assumed that efforts towards modernisation of network coupled with efforts of the on-ground staff must have improved the loss due to theft by a considerable measure. Given the opacity of data, the exact measure and improvement in loss due to theft is not examined in this paper. With this backdrop, continuation of efforts towards mitigation of theft is suggested.

# 1. Introduction

The business of the electricity sector starts with the generation segment, followed by transmission, and finally electricity distribution utilities or distribution companies (DisComs), which provide the last-mile connectivity. Principal responsibilities of DisComs include procuring sufficient power to meet the demand, maintaining the distribution network to keep it operation-ready, supplying the procured power to retail consumers, and recovering the cost of supply from consumers, besides a host of other mandatory functions under the Electricity Act, 2003 and Companies Act 2013.

These utilities are governed by the respective regulatory commissions, which provide necessary regulatory oversight. The regulators keep a tab on DisComs' annual revenue requirements, determine retail consumer tariffs, and facilitate recovery of the cost of supply from consumers according to pre-determined retail tariffs, etc. Under such a well-regulated and secure business model, the DisComs are not supposed to incur business losses. However, the majority of DisComs have observably suffered significant operational gaps and financial losses over the last two decades (NITI Aayog, 2021).

An earlier analysis critically discussed the above issue of financial gap and accumulated losses in the distribution segment (Devaguptapu & Tongia, 2023). The analysis showed that the gap due to technical losses (also known as billing losses or line losses) and commercial losses (also known as collection losses) together constitute only one-third of the cumulative gap (FY2007–FY2021), while other issues such as non-payment of subsidies by the government, regulatory assets, non-cost reflective tariffs, etc. form the rest. This disproved the general belief that Aggregate Technical and Commercial losses (AT&C) are the only reason for the accumulation of financial gaps and that, if AT&C losses are restricted to the normative mark of losses as approved by the regulators, DisComs would not make any losses.

The above finding highlights that while billing and collection losses are not the only reason for DisCom losses, they are significant as well. Therefore, any improvement in billing and collection losses is expected to ease the financial position of DisComs.

On the other hand, over a lengthy period, the issue of AT&C losses has remained a matter of great concern for policymakers, regulators, utilities, and other stakeholders alike. Several initiatives were taken by the policymakers and regulators through different policy prescriptions, regulatory initiatives, incentive schemes, financial support frameworks, etc. Although electricity distribution falls within the domain of states, the Central Government has shown keen interest in strategising loss reduction and has initiated multiple measures to address the problem of AT&C losses.

In this context, as well as in continuation of the work done earlier (Devaguptapu & Tongia, 2023), this paper analyses the billing loss component in greater detail over 17 years, i.e. from FY2006-2007 through FY2022-2023, besides exploring the capital investments made in the electricity distribution sector.

It is widely considered that the billing losses are due to poor quality and under-maintained networks that cause loss of electricity when it is transmitted from the DisCom's periphery (where electricity enters the DisCom network from inter-state lines) to the end-consumer. This situation calls for large investments in modernising and augmenting the network and making it more efficient to meet the continued growth in demand. Apart from network issues, pilferage of electricity adds another layer to the billing losses. This paper also explores the challenges in measuring loss of energy due to pilferage.

Regarding the issue of strengthening the distribution network, it is carried out with the financial support received through different channels. The first one is the 'Repairs and Maintenance' (R&M) head, under which the distribution utilities spend resources to carry out repairs, replace the faulty components with spares, and undertake minor augmentation works to meet the changing load connected to the network. The funds under this head are a pass-through in the annual revenue requirement approved by the regulator. Timely repairs and upkeep of the network facilitate mitigation of immediate and avoidable billing losses.

However, in addition to R&M, DisComs need to undertake full-scale augmentation and development of the network to meet future loads. To meet this activity, DisComs incur capital expenditure on big ticket items related to the network. Ideally, revenue to meet this capital expenditure is expected to

flow from DisCom's own resources. However, given the financial losses suffered by the DisComs and the insufficiency of funds through tariffs to improve billing losses, they need support from external sources.

With this backdrop, let us understand the different financial support schemes announced by the central government to help the distribution sector. The improvement of AT&C losses remained one of the key objectives for the majority of these schemes. This support assumes importance as the R&M quantum does not seem to be sufficient to contain AT&C losses. While allowing access to funds under these schemes, the government mandates that the DisComs also improve upon AT&C losses.

The Central government schemes fall into two broad categories: i.e. development of the distribution segment and financial restructuring. Schemes such as Accelerated Power Development Programme (APDP), Accelerated Power Development Reforms Programme (APDRP), Restructured Accelerated Power Development Reforms Programme (R-APDRP), Integrated Power Development Scheme (IPDS), Revamped Distribution Sector Scheme (RDSS), etc. fall into the first category.

There are other rural electrification schemes such as Rajiv Gandhi Gramin Vidyutikaran Yojana (RGGVY) and Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) which are aimed at connecting the rural areas to the main grid. These also facilitate strengthening of the network and partly facilitate AT&C loss reduction. The other schemes such as BK Chaturvedi Committee Recommendations, Ujjwal DisCom Assurance Yojana (UDAY) etc. are essentially aimed at providing financial restructuring to the DisComs.

The first category of schemes is essentially aimed at improving operational efficiency through operational support, grants, specially curated loans, etc. This paper analyses these schemes and examines their impact on improving billing losses. Broadly, these schemes mandate the achievement of targets on several parameters, and improving billing losses is one of them. In some cases, upon achieving pre-specified billing loss targets, the schemes facilitate the conversion of loan components (if any) into grants.

However, we should not lose sight of the fact that, in case schemes mandate DisComs to reduce losses without any attractive incentive, they become unfunded objectives/targets and DisComs may ignore such mandates. As such, this paper does not include any analysis of financial restructuring schemes such as recommendations of the Montek Singh Ahluwalia Committee, B K Chaturvedi Committee, UDAY Scheme, etc.

Overall evaluation of the performance of DisComs is carried out on multiple parameters, including operational efficiency through measuring improvement of AT&C losses. Billing losses indicate the power lost in the network and are integral to AT&C losses, therefore it is necessary to examine their role in the overall financial gap suffered by DisComs. The energy lost in this segment can never be recovered in the future and is lost forever. Although billing losses are improving over time, for a substantial number of DisComs, the losses overshoot the targets mandated by the regulator. Hence, it is important to understand the causality of billing losses as well as the impact of money invested in the sector seeking to improve the losses.

Given the above, this paper focuses on billing losses and their improvements over time while analysing the issues of the quantum of expenditure towards improvements in billing efficiency and how expenditure under 'R&M' and 'capital expenditure' (capex) complement each other. Based on the above, the paper also provides policy implications based on the inevitable heterogeneity across and within DisComs.

This paper consists of six subsequent sections, which are summarised below:

- ***Literature Survey***

  This section briefly explores various reports on billing losses and various government schemes brought out by the Forum of Regulators (FoR), Ministry of Power, NITI Aayog, Comptroller and Auditor General, etc. It attempts to understand their observations on the objectives of schemes, their impact at a granular level in improving billing losses, their interlinkages with other support schemes, their impact over a longer period, etc.

- ***Objective and Methodology***

  The paper is aimed at addressing three primary questions for public sector electricity distribution utilities across India, i.e., 1) What is the quantum of expenditure towards network strengthening and how does it compare with improvements in billing efficiency? 2) What has been the role of governmental support (e.g., schemes) for such investments and improvements? and 3) What are the policy implications based on the inevitable heterogeneity across and within DisComs?

- ***Understanding the Criticality of 'Billing Losses'***

  This section briefly explains various components that constitute overall AT&C losses and delves deep into the billing loss component. While further discussing various parts of billing loss, i.e., loss due to technical reasons, loss due to theft, etc., this section attempts to analyse the pan-India billing loss trajectory over sixteen years up to FY2021-2022.

- ***Investments for Improving the 'Billing Losses'***

  This section discusses two important channels of investment available for achieving the bigger goal of 'billing loss reduction', 'repairs and maintenance (R&M) of the network', and 'capital investment for network upgradation, network augmentation'. While exploring these two streams in detail, this section also examines their evolution, their constituents, their evolution, etc. Importantly, this section also explores investments received under various central government schemes since FY2000-01.

- ***Analysis and Findings***

  This section examines various challenges in the classification and aggregation of investments, efficacy of investments etc. The analysis also explains DisComs' heterogeneity in investments vis-à-vis billing loss reduction achieved. Considering the scope available for billing loss improvements, this section finally argues for customised sustained investments over a longer period to better the billing loss levels, including theft reduction.

- ***Policy Implications and Recommendations***

  It recommends for making available granular data in the public domain, periodical energy auditing, measures for effective theft control, customised long-term investments specifically aimed at effective billing loss mitigation, further tightening of loss targets besides breaking down the loss reduction targets to the distribution transformer (DT)-level, etc.

## 2. Literature Survey

Given the depth and expanse of support extended by the Central government to the electricity distribution sector, multiple agencies have evinced interest in examining these support schemes. In general, these studies are restricted to any one of the schemes, and interlinkages with other support schemes were left untouched. Further, these studies have not included multiple schemes at one go to explore their impact on the continuum.

The Forum of Regulators (FoR), in its report on loss reduction strategies (FoR, 2008), examined the connected issues such as (i) the technical interventions made by different states/utilities; (ii) theft control measures; and (iii) suitable incentive/disincentive schemes for rewarding/penalising the areas with low/high loss levels, etc. While recommending the segregation of billing and collection losses, the report argued for systematic estimation of the energy supplied to unmetered agricultural consumers. Very interestingly, the report also recommended identifying the payback period and carrying out a life cycle cost analysis concerning the appropriate technological interventions aimed at reducing technical losses. The report also suggested that State Electricity Regulatory Commission (SERC) encourage suitable local area-based incentive and disincentive schemes for the staff of the utilities linked to a reduction in losses.

The Ministry of Power, in its report on the impact assessment study of R-APDRP of go-live towns (MoP, 2016a), examined the key objectives of the R-APDRP scheme and assessed the outcomes in terms of improvement in AT&C losses, reliability of power, consumer empowerment, and delivery of e-services, complaint redressal mechanism, etc. The study considered a sample size of 76 towns and observed AT&C loss reduction in 85% of these towns in a range of 1% to 54%. This loss reduction corresponds to approximately Rs 185 crore and extrapolated the monetary benefits to touch the mark of Rs 5,000 crore per annum. Considering the focal point of the study, i.e., the impact of investment through central government schemes on improving billing losses, it is observed that the sample size of 76 towns to assess billing loss improvement could have been bigger. Apart from this, this study does not include the flowing benefits of previously connected schemes such as APDP, APDRP, etc.

NITI Aayog, in its report on turning around the power distribution sector–learnings and best practices (NITI Aayog, 2021) provided a holistic picture of challenges and issues faced by DisComs. It provided the best practices from the sector's past experiences. The report, while categorising the challenges into four categories: structural, regulatory, operational, and managerial, also touched upon the support schemes of Central government. However, the report does not provide enough insights into the efficacy of central government initiatives to contain billing losses. The report observed that the sector is very diverse, and the one-size-fits-all approach needs to be changed.

The FoR, in its report on best practices and strategies for distribution loss reduction (FoR, 2016), provided a detailed analysis of various initiatives undertaken by the distribution utilities towards distribution loss reduction till FY2013-2014. The report included a review of the international practices across four other countries (Oman, Iran, Brazil, and Uganda). The impact of different programmes, R-APDRP, the financial bailout schemes, and DDUJGY, shown in this report, was limited till 2016. The analysis is limited to qualitative aspects, perhaps owing to data limitations.

The report of the Comptroller and Auditor General of India on R-APDRP (Report No. 30–Performance Audit) provided a detailed assessment of the outcomes of R-APDRP vis-à-vis its intended objectives (CAG, 2016). It was observed that the actual budgeted amount was lower than the amount originally envisaged while the releases were even lower. It was also pointed out that the counterpart funding was not tied up by many utilities within the prescribed period. In addition to the shortcomings in adherence to established procedures, instances were observed where revision of the cost of projects took place. The report critically brought out that the AT&C losses had increased relative to the baseline or could not be generated in more than 100 towns that had been declared 'Go Live'. Besides, the methodology used for calculating the AT&C losses, though laid down, was not followed uniformly, leading to varying estimates of the AT&C losses.

The studies specified above largely adhere to the objectives envisaged in different government-sponsored schemes. As such, the reports have not explored the granular level impact of the schemes, except in report of the Comptroller and Auditor General of India on R-APDRP (Report No. 30–Performance Audit) (CAG, 2016) wherein a brief period of R-APDRP was explored into. However, none of the reports provide a holistic picture of the flow of funds (under different schemes) aimed at billing loss reduction. Additionally, any analysis of the projected billing losses and their impact in rupee terms on the annual revenue requirement of the distribution utilities is also missing. Hence, this current study, which is aimed at capturing all the missing links above, assumes importance.

## 3. Objective and Methodology

It is well known that billing losses in the majority of DisComs have exceeded the approved levels set by the regulators and contributed to the overall financial gap suffered by DisComs. Against this backdrop, it is also recognised that investments have been made over a lengthy period through different channels seeking to improve the billing losses.

In this paper, we examine annual improvements of billing losses over time, extending the earlier work (Devaguptapu & Tongia, 2023) through prior years and up to FY2022-2023 *vis-à-vis* the investments made towards loss mitigation during the period. It is known that extra billing loss means, purchasing more power than normatively required to meet the expected demand. If the objective is to understand the efficacy of investments in improving the billing losses, we need to understand how successfully these investments have brought down such additional and undesirable power purchase costs.

Out of the total 70 distribution utilities (covering public utilities, state power departments, integrated utilities, and private utilities), unless stated otherwise, this paper explores in detail the billing loss and investment analysis of 56 public utilities, which includes most public utilities and state power departments. It may be appreciated that due to the non-availability of consistent time series data for all DisComs, we limit our analysis to public sector DisComs.

For this study, we relied upon the data available in the public domain, i.e. reports published by the Parliamentary Standing Committee on Energy on the Lok Sabha website, reports provided on the websites of Power Finance Corporation (PFC), REC Limited (formerly Rural Electrification Corporation Limited), SERC, Joint Electricity Regulatory Commissions (JERC), various DisComs, FoR, Central Electricity

Regulatory Commission (CERC), etc. It is observed that with various data sources not being consistent across their headings and metadata, we have tried to segregate and standardise the data across relevant components. Further, the DisCom-level break-up of loan and grant components under various government-sponsored schemes is also not available. Under these constraints, our focus is more on trends and big-picture findings as opposed to final digit-level accuracy.

We attempted to understand the billing loss improvements in rupee terms by considering the pan-India average cost of power procurement. On the other hand, the channels of investment are primarily 'R&M expenditure' and 'capital expenditure' (capex) by DisComs. DisCom capex has many tributaries: grants from the government, loans under government-sponsored schemes, loans under these schemes later converted to grants, loans obtained by DisComs directly towards network strengthening, loss reduction, asset building, etc.

While we acknowledge and analyse the financial support received by DisComs under various government-sponsored schemes such as APDP, APDRP, R-APDRP, IPDS, RDSS, RGGVY, DDUGJY, etc. we understand that these investments are subsumed in the overall capital expenditure made by the DisComs. It is also understood that while the flow of money through government-sponsored schemes happens as per the timelines specified under each scheme, the regulators do not have visibility of the same at the time of tariff setting.

Given that reasons for the occurrence of high billing losses, loss improvement trajectory, the impact of various channels of investment, etc. are heterogeneous across DisComs, strong generalisations are difficult. Therefore, measures for future improvements in billing losses are required to be different for each DisCom based on its specific challenges.

While considering the government-sponsored schemes as a key measure towards billing loss mitigation, we have not considered the financial restructuring plans and schemes such as financial restricting support under Montek Singh Ahluwalia Committee recommendations, Financial Restructuring Plan of 2021, Ujjwal DisCom Assurance Yojana, etc. We observe that these schemes are essentially to provide financial headroom for DisComs rather than having any impact on their technical operations.

The analysis includes three major segments: firstly, the measure of billing losses; secondly, the measure of investments under R&M and capex. After we understand these two segments, we examine the challenges involved in understanding the impact and efficacy of investments. In this process, we excluded funds inflow under government schemes such as Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA), which are not connected with loss improvements.

The measure of billing losses brings the challenge of consumption through connections that are unmetered and metered but not read. As regards the investments, they are multipurpose and meant for system improvement to de-congest the current network, loss mitigation, system strengthening to meet future loads, civil works, renovation and modernisation of back-end systems, etc. Given this complexity, it is not clear as to what fraction of the investment is specifically meant for loss mitigation.

# 4. Understanding the Criticality of 'Billing Losses'

## 4.1 What Constitutes DisCom Billing Loss

AT&C loss is a widely recognised problem in the electricity distribution business in India. AT&C loss is a combination of two distinct kinds of losses, technical or billing loss (in kWh) and commercial or collection loss (in rupee terms). During FY2023 alone, billing loss exceeded 13%, which in rupee terms is valued at more than Rs 89,500 crore. Of course, this needs to be seen with reference to the loss level allowed by the regulators. As the loss achieved exceeds the regulators' normative mark, the difference between the two is the value that causes worry.

Coming to the details, billing loss is the amount of power lost in the network, i.e., loss of energy during transmission of power from the input point at the DisCom periphery up to the consumer premises. This loss happens due to a host of technical reasons including sub-optimal network configuration, overloading of the existing network, absence of upgrading of equipment, low HT-LT ratio, poor repair and maintenance, non-installation of capacitors for power factor correction, etc., besides theft of electricity. The energy lost in this segment can be treated as energy lost forever and cannot be recovered in the future.

Often, lengthy 11 kV (and below) lines are laid over long distances to connect rural areas and hamlets scattered over large swathes of land, leading to significant line losses. Also, the distribution transformers are not optimally located to connect all consumers. This leads to wheeling of power at extremely low voltages for consumers to receive at the farthest end, also adds to the line losses. For a given load, if the power factor is low, a higher current is drawn, thus leading to more line losses.

In addition to the losses in the network due to technical reasons, the energy that is lost due to theft also forms part of the overall billing loss. The measurement of loss due to theft, largely due to direct hooking or connecting and meter-bypassing, is very difficult to assess. Only a fraction of the energy pilfered is captured and a significant component of theft is left undetected.

Accounting for billed energy also comes with a host of uncertainties as many connections (including most agricultural consumers) are still unmetered. Such unmetered consumption is calculated based on certain assumptions, such as hours of supply provided, capacity of the pump sets connected to the feeder lines, etc.

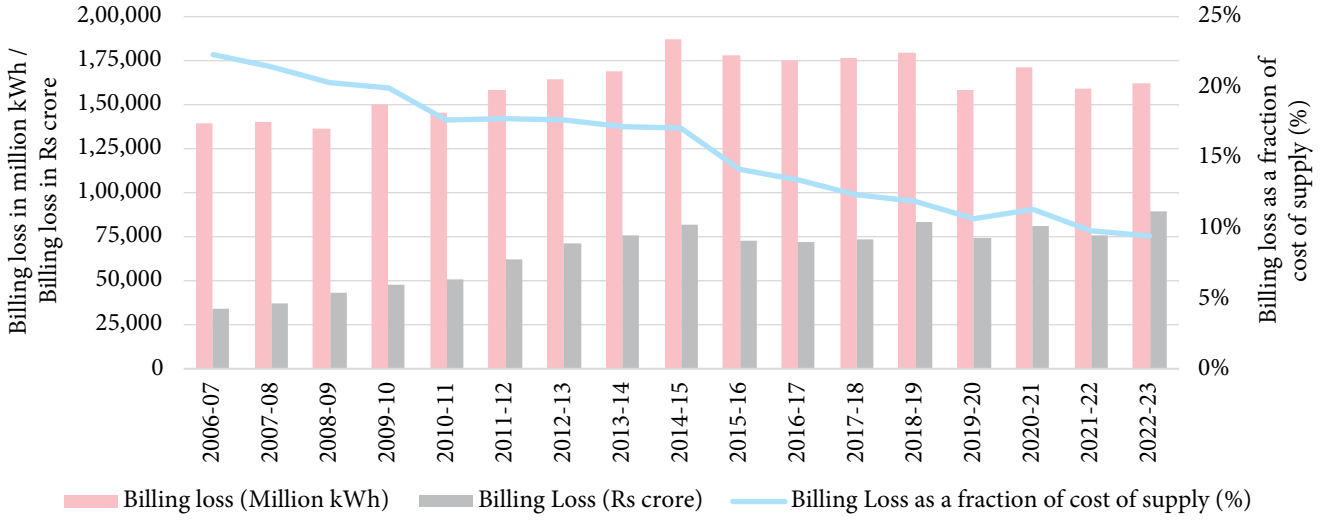
Even in the case of metered agriculture connections, periodic meter-reading remains a sizeable challenge, leaving a big scope for the generation of bills based on estimated consumption. Such estimations are not being made public, leaving the percentage of error in billing loss calculations invisible and unchecked. The good part of the metering story is that new connections are mandatorily metered e.g. the SAUBHAGYA electrification scheme mandates that connections must have a meter.

## 4.2 Billing Loss Trajectory Over the Last 17 Years

This section examines the evolution and improvement of billing losses of public sector DisComs over 17 years i.e. FY2007 to FY2023. Primarily, the billing losses are found to be heterogenous across different DisComs over the years. The aggregate billing loss of all utilities covered under this study, as a percentage of net energy input, has substantially improved from 26.17% in FY2006-2007 to 13.28% in FY2022-2023.

But in terms of energy (in million kWh), the loss remained between 136.6 billion kWh to 186.7 billion kWh **(Figure 1)**, whereas it shows improvement in percentage terms due to growth in the denominator i.e. consumption. However, the energy loss in absolute terms consistently remained above the mark of 150 billion kWh continuously for eleven years from FY2011-2012 onwards. To be more precise, the overall billing loss as a fraction of net input energy improved at a Compound Annual Growth Rate (CAGR) of negative 3.98%, while that of energy loss remained less than 1%.

**Figure 1: Billing Losses During FY2006-2007 and FY2022-2023 in million kWh, Rs crore, and as a Fraction of the Cost of Supply**




*Source: Authors' analysis using data from PFC Report on Performance of Distribution Utilities for FY2006-2007 to FY2022-2023.*

Generally, billing loss is measured in terms of energy (kWh) and as a percentage of net input energy at the DisCom's periphery. Any improvement in billing loss results in moderating the power procurement appropriately. Hence, against the general norm of referring to the billing loss in energy, it needs to be examined in rupee terms as well. The billing loss in rupee terms, has worsened from Rs 34,294 crore in FY2006-2007 to Rs 89,554 crore in FY2022-2023. However, the same as a percentage of the total cost of supply has shown remarkable improvement from 22.3% to 9.5% during the same period as shown in **Figure 1**.

For eight years from FY2006-2007 onwards, billing loss improved from 26.2% to 17.69% by FY2013-2014. The rapid increase in the cost of power procurement from Rs 2.47 per kWh to Rs 4.49 per kWh, resulted in increased billing loss in rupee terms, recording a cumulative average growth close to 12%.

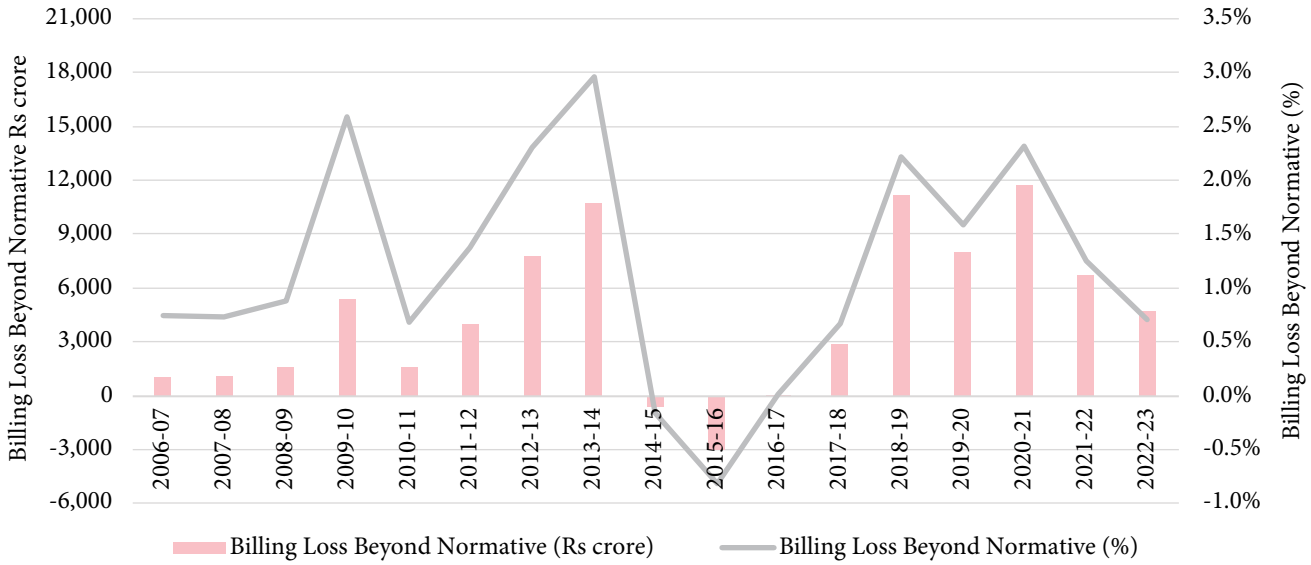
During the next nine years, billing loss improved from 21.2% to 13.3%, which is significant. Contrary to the trend observed from FY2006-2007 for eight years, this billing loss (%) improvement facilitated a reduction in energy loss by 13.3%. During the period FY2014-2015 to FY2022-2023, the power purchase cost also witnessed moderate growth, from Rs 4.40 per kWh to Rs 5.52 per kWh, which further stabilised the rupee loss, recording a growth of around 9%.

As such, billing loss impact is better seen in terms of its behaviour concerning the normative level set by the regulator. Billing loss remaining below the normative mark is considered positive, whereas anything beyond the limit is a loss to be borne by DisCom as its business loss. To simplify, a loss of 20% against the regulator-set target of 21% is seen as better in comparison to a loss of 18% against the target of 17%.

Although the billing loss seems to be improving as a percentage of net energy input, examination of the same concerning the regulator-set target throws a different picture. Except during FY2014-2015 and FY2015-2016, the rest of the period under study witnessed occurrence of losses in rupee terms for DisComs as they exceeded their normative loss level. This sudden change in billing loss improvement can be attributed to the revision in loss levels by the regulators in the context of joining the UDAY scheme by the DisComs.

This loss is seen as one of the critical components of the total financial gap (i.e. difference between the cost of supply and revenue realised). **Figure 2** shows that as a result of billing loss exceeding the normative mark, rupee losses increased continuously during two spells of four years each, i.e. FY2007 to FY2010 and FY2011 to FY2014. After a minor dip during FY2015 to FY2017, losses have been cyclical, leaving a cumulative loss of Rs 74,766 crore over 17 years.

**Figure 2: Billing Losses During FY2006-2007 and FY2022-2023 Beyond Normative Set by the Regulators in Rs crore and as Percentage of the Total Financial Gap**




*Source: Authors' analysis using data from tariff orders of different DisComs, REC Reports, and PFC Report on Performance of Distribution Utilities for FY2006-2007 to FY2022-2023.*

*Note: Annual normative loss level is an aggregate value calculated using different levels determined by various state regulators.*

However, one should not lose sight of the fact that billing loss improvement happened owing to sustained efforts by the stakeholders at all levels. Considering the current improvement trajectory that has stabilised the loss in energy and rupee terms, it calls for more focus on improving billing losses at a rapid pace, so that its share in the total financial gap could be reduced. Hence, it is necessary to better understand the various channels that worked in impacting the billing losses trajectory and identify the critical insights.

# 5. Investments for Improving 'Billing Losses'

Electricity reaches the retail consumer through transmission, sub-transmission and distribution lines. Transmission of electricity through this maze of networks is complex, and loss of electricity in the network is an inherent characteristic of the transmission. The losses that occur within the network are the 'technical losses' (also known as 'network losses', 'billing losses', or 'line losses').

Although better quality of the network, including cables, substations, transformers, etc., helps reduce the billing losses, given their inherent nature, billing losses can never be fully removed. Besides the quality of the network, loss due to theft is another element that adds to the billing losses. Electricity can be pilfered, through hooking onto the network or illegal connectivity from poles, etc. To reduce losses, it takes a combination of measures including better operation and maintenance of the network, consumer education, consumer awareness, effective vigilance, etc. These initiatives need capital investment in varying degrees.

In this backdrop, various channels available for achieving the bigger goal of 'billing loss reduction' are explored in this section. The measures to improve billing losses are essentially carried out by investing under two streams: firstly, investment towards 'repairs and maintenance' (R&M) of the network, and secondly, through capital investment for network upgradation, network augmentation to meet the new loads, loss mitigation, etc.

## 5.1 Repairs and Maintenance (R&M) of Distribution Network

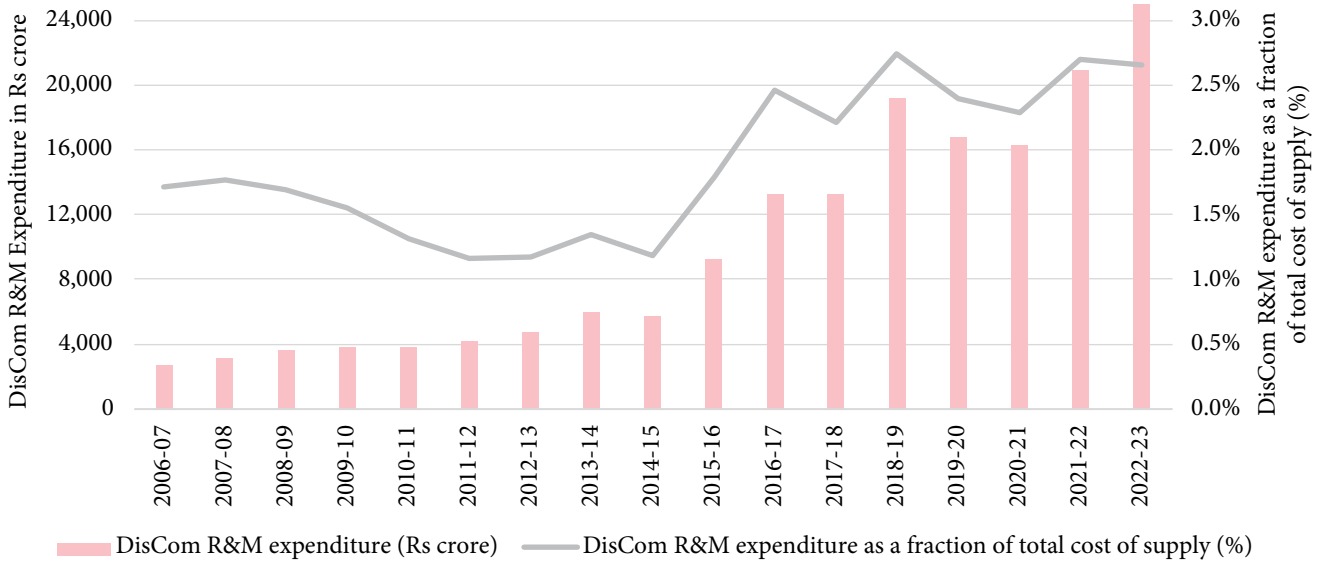
The distribution network is a vital cog in the system and provides last-mile connectivity to the consumer, hence, availability of the network in its prime is desirable. A well-maintained network not only facilitates keeping energy losses low but also helps with uninterrupted power flow and ensures a longer operational life span of the equipment. The shutdown of the power supply entails enormous economic loss to the gross productivity of the area of supply as well as financial loss to the distribution utility.

Considering the enormous technical and economic value delivered by a well-maintained electricity distribution network, regulators ensure the availability of commensurate revenues to the DisComs, as part of their total annual revenue requirement. The money under the budget head 'Repairs and Maintenance' (shortly, R&M, excluding administrative and general expenses) is utilised by the DisComs for carrying out various activities, including preventive maintenance, repairs, minor augmentation, purchase of spares, replacement of components that have outlived their utility, etc. Funds earmarked under this budget head get subsumed in retail tariff to be paid by the consumer.

The availability of R&M funds directly facilitates various network upkeep activities, thereby forming an important revenue channel for the mitigation of network losses. **Figure 3** indicates the R&M expenditure of all public sector DisComs for 17 years from FY2006-2007 to FY2022-2023. During this period, a total of Rs 1,71,522 crore has been spent under R&M. From FY2006-2007 to FY2014-2015, R&M investment as a fraction of the total cost of supply declined until FY2013-2014, largely remaining less than 2% of the cost of supply. This may be largely due to DisComs' focus on procuring power to meet the growing demand and addressing billing losses through non-cost-intensive measures.

From FY2015-2016 onwards, there appears a phase-shift with a sudden increase in funds under this head. From FY2016-2017 onwards, it consistently breached the 2% mark and by the end of FY2022-2023, it remained more than 2.5%. The increase can also be seen in rupee terms as well as a fraction of the total cost of supply. However, during the last five years under study, i.e. from FY2018-2019 to FY2022-2023, fluctuations could be seen in terms of absolute values as well as the percentage of total cost of supply.

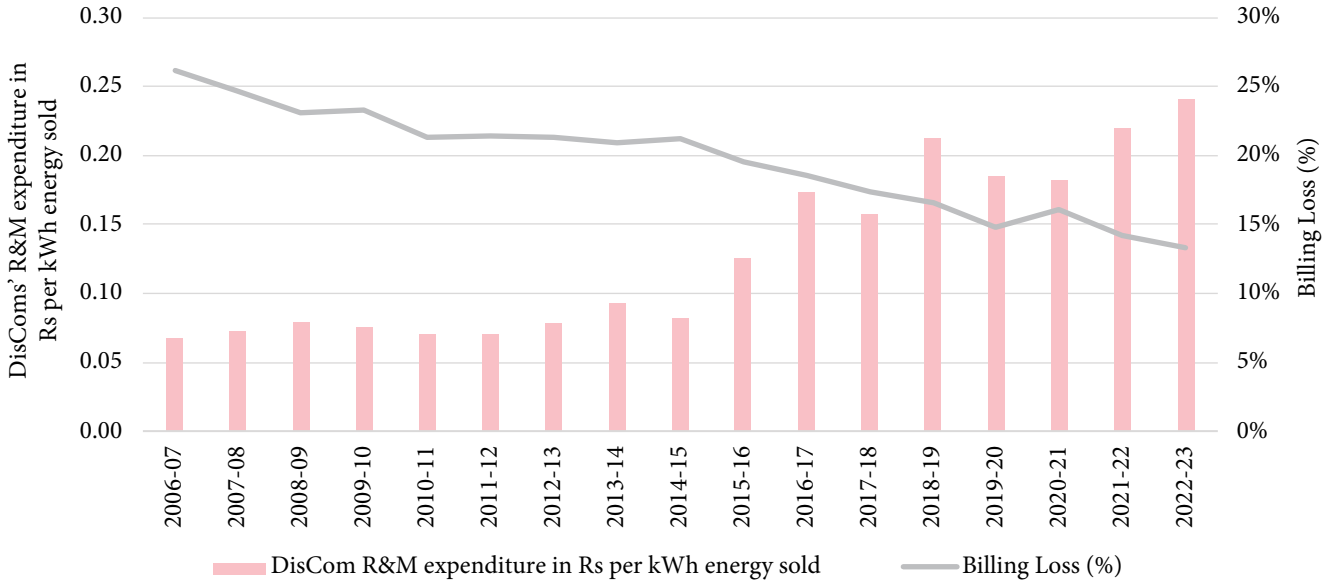
**Figure 3: DisCom Repairs and Maintenance Expenditure (Rs crore) and as a Fraction of Total Cost of Supply (%)**




*Source: Authors' analysis using data from PFC Report on Performance of Distribution Utilities for FY2006-2007 to FY2022-2023.*

*Notes: From FY2015-2016 onwards, expenditure under R&M has not been explicitly provided. Hence, a normative 57% (based on the past period trend) of the 'Other Expenditure' is considered as R&M expenditure.*

**Figure 4: DisCom R&M Expenditure in Rs per kWh Energy Sold vs. Billing Loss (%)**




*Source: Authors' analysis using data from PFC Report on Performance of Distribution Utilities for FY2006-2007 to FY2022-2023.*

*Notes: From FY2015-2016 onwards, expenditure under R&M has not been explicitly provided. Hence, a normative 57% (based on the past period trend) of the 'Other Expenditure' is considered as R&M expenditure.*

**Figure 4** validates the observations made in previous paragraphs about the expenditure under the R&M. At the normalised value of R&M expenditure in terms of its value per unit energy sold, there is hardly any growth in R&M expenditure for nine years starting from FY2006-2007. During FY2007 to FY2011, the billing losses came down from 26.2% to 21.3%. From FY2011 to FY2015, the billing losses almost stagnated. Also, from FY2016 to FY2023, with the R&M expenditure per kWh sold going up, the billing losses have come down as low as 13.3%.

However, it is important to note that the entire R&M expenditure may not be construed as the money used in the maintenance of the network, as a part of it goes towards maintenance and upkeep of various other

segments, like civil structures, IT infrastructure, transport, other miscellaneous infrastructure, etc. The precise data related to the break-up of money used for maintenance of network and non-network infrastructure is not available. Hence, in subsequent sections of this paper, we relied on various assumptions and examined the impact of R&M expenditure on billing loss reduction under different scenarios.

While taking cognisance of the above, broadly there appears a consistency between R&M expenditure and billing loss improvement. In other terms, R&M expenditure being one of the consistent revenue channels, its criticality for improving the billing losses is indicative. In addition to the funds available under the R&M expenditure budget head, capital expenditure (capex) is another important channel that facilitates the availability of investments towards improving billing losses, which is explored in the following sections.

## 5.2 Capital Expenditure

Capital investment in the DisCom business for upgradation, modernisation, and augmentation of the network is critical for its readiness to meet future demand besides addressing the crucial issue of billing losses. The Tariff Policy notified by the Central government (MoP, 2016b) also prescribes the installation of distribution Supervisory Control and Data Acquisition (SCADA) (PIB, 2023) to reduce theft of power, further enabling DisComs in effective distribution management and energy audit functions. An aged network that has outlived its utility, low-capacity distribution transformers, and other low-quality equipment leads to high network congestion, more heat losses, more pilferage, and finally increased technical losses and unreliable supply of power to the end consumers. Besides all the above, a dilapidated network always throws a challenge to the safety of consumers.

A recent NITI Aayog study on distribution reforms (NITI Aayog, 2021) observed that a high number of power cuts without prior notification and poor grid quality leads to low revenue realisation. To bring down losses and reduce fault rates, it is required to carry out detailed load flow studies and upgrade various elements of the network. All this requires substantial investment.

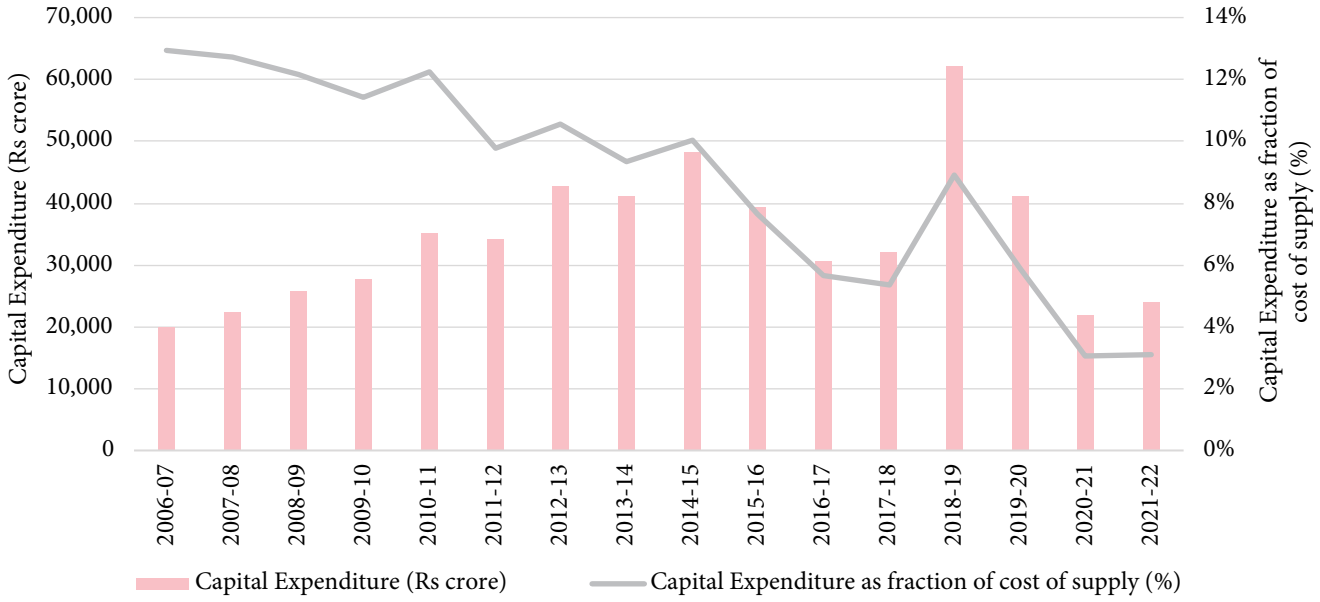
In the Indian context, investment comes from both R&M and capex. While examining the capex, one should not ignore the fact that capex includes funds from different channels, i.e. central government grants, state government grants, equity for the creation of assets, loans from commercial institutions, soft loans from financial institutions, loans from the government, loans converted into grants, etc. However, while analysing the trends and efficacy of capex, care needs to be taken to exclude revenue flows from those government schemes (such as SAUBHAGYA) which do not have billing loss mitigation as one of their objectives.

Given the complexity of the capex structure, the primary challenge is the non-availability of data (in the public domain) with the break-up of funds received and spent under different sub-heads. Additionally, grants under central government support schemes that get subsumed in the overall capex come with a longer-time horizon and carry loss mitigation as one of the objectives (in almost all the schemes). Therefore, it is relevant to understand the impact of these grants on loss mitigation.

Measuring capex meant for billing loss mitigation is another critical challenge. In the context of the non-availability of the break-up of capex figures in the public domain, we tried to gather the capital investment by calculating a change in the value of the sum of 'net tangible assets and work in progress', which can be considered closer to the actual capex. However, within this capex, further break up of investments is not available to understand the actual fraction of capex used for loss mitigation.

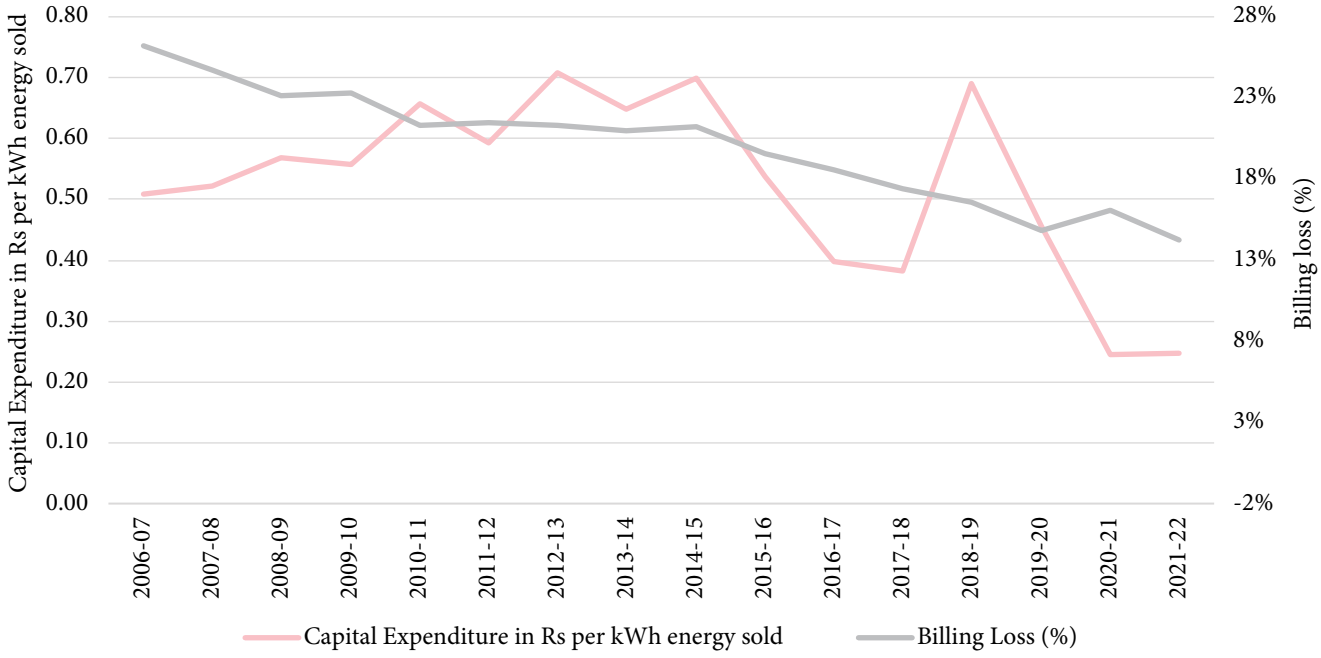
Since FY2006-2007, capex increased in absolute rupee terms continuously for eight years and then it fluctuated during the rest of the period **(Figure 5)**. However, capex as a fraction of the total cost of supply has continuously declined except for a couple of years in between. The same, upon normalising against the net energy sold, showed marginal growth during the first nine years as shown in **Figure 6**, which rapidly declined during the next phase. Here we are depicting the total capex, but in practice, only a part of the capex is used for mitigation of billing losses. In this context, it may further be inferred that capex investments meant for addressing billing losses might have effectively complemented other investments such as R&M and non-financial initiatives, which facilitated billing loss reduction.

**Figure 5: Capital Expenditure in Rs crore and as a Fraction of Total Cost of Supply During the Period FY2006-2007 and FY2021-2022**




*Source: Authors' calculation based on the data extracted from PFC Reports on Performance of Distribution Utilities for FY2006-2007 to FY2021-2022.*

**Figure 6: Capital Expenditure in Rs per kWh Energy Sold and Billing loss (%) During FY2006-2007 and FY2021-2022**




*Source: Authors' calculation based on the data extracted from PFC Reports on Performance of Distribution Utilities for FY2006-2007 to FY2021-2022.*

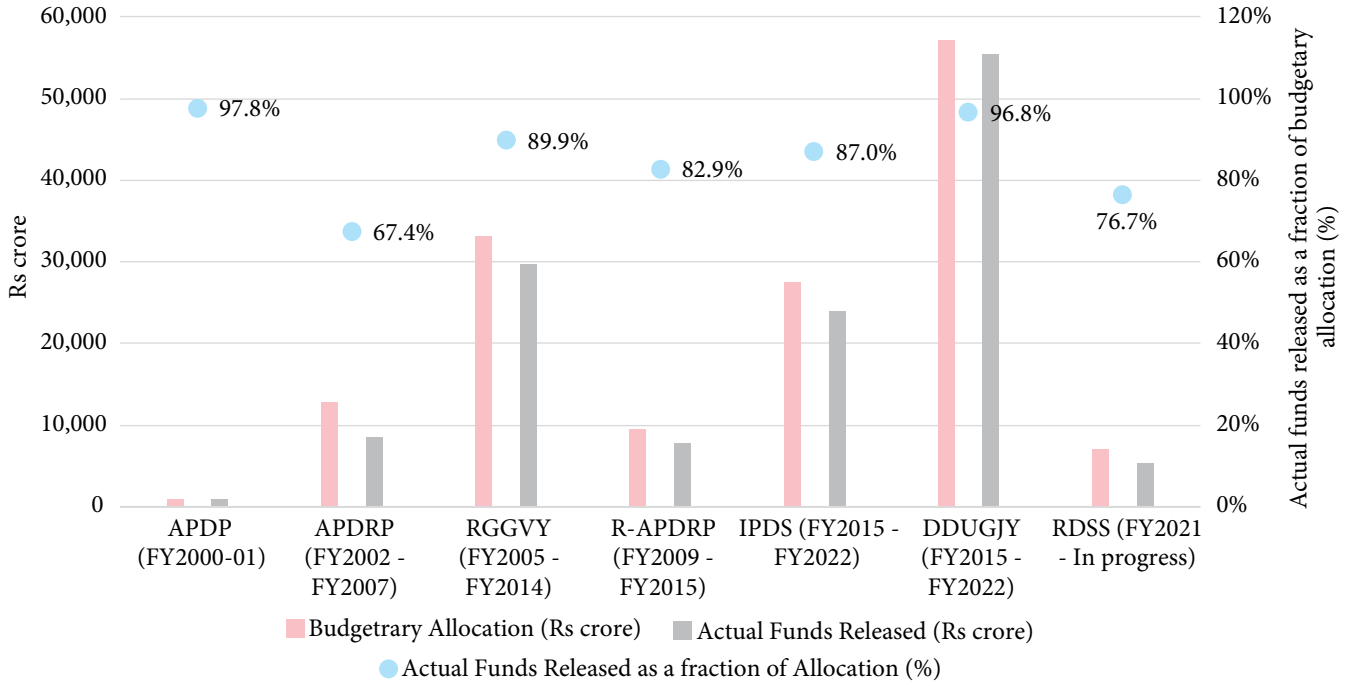
## 5.3 Central Government Schemes Towards Improving 'Billing Losses'

Electricity is a concurrent subject as per the Seventh Schedule of the Constitution of India. This entails both central and state governments to enact laws. By drawing powers from appropriate enactments, both the governments take initiatives to resolve the problems. Taking a holistic view of the sectoral development, the Central government formulated multiple schemes aimed at developing the infrastructure of the power sector. This is essentially carried out through a combination of Gross Budgetary Support (GBS) and Extra Budgetary Resources (EBR). This section explores various such schemes related to electricity infrastructure development with 'billing loss improvement' as a key result area. To ensure a focus on billing loss improvement, schemes aimed at the financial restructuring of DisComs are excluded from this analysis.

Before the schemes are discussed in terms of their allocation of funds versus their usage, it is necessary to appreciate the fact that the launch of schemes takes place by announcing the total allocation of budgetary allocation, objectives of the scheme along with timelines for the release of funds. In practice, the annual budgetary allocation of funds is done through the concerned ministry's annual demands for grants, which marginally differ from the initial plan. However, the actual release of funds during the year further deviates from the annual budgetary allocation. So, there is a change in figures between 'initial launch', 'annual budgetary allocation', and 'actual release'. Apart from the above, all data points with relevant break-ups are not available in the public domain. We tried to draw an overview of these central government-sponsored schemes with the limited information available.

Overall, it is worth noting that the grants envisaged at the time of the launch of the schemes differ from actual annual budgetary allocations, which further differ from the actual release of funds. **Figure 7** and **Figure 8** depict a summary of funds allocated under various central government schemes (which are discussed below) through annual budgetary resources and the actual release of funds during the period of their operation.

**Figure 7: Funds Allocated Under Budget vs. Funds Released Under Various Central Government Schemes (FY2001-FY2022)**



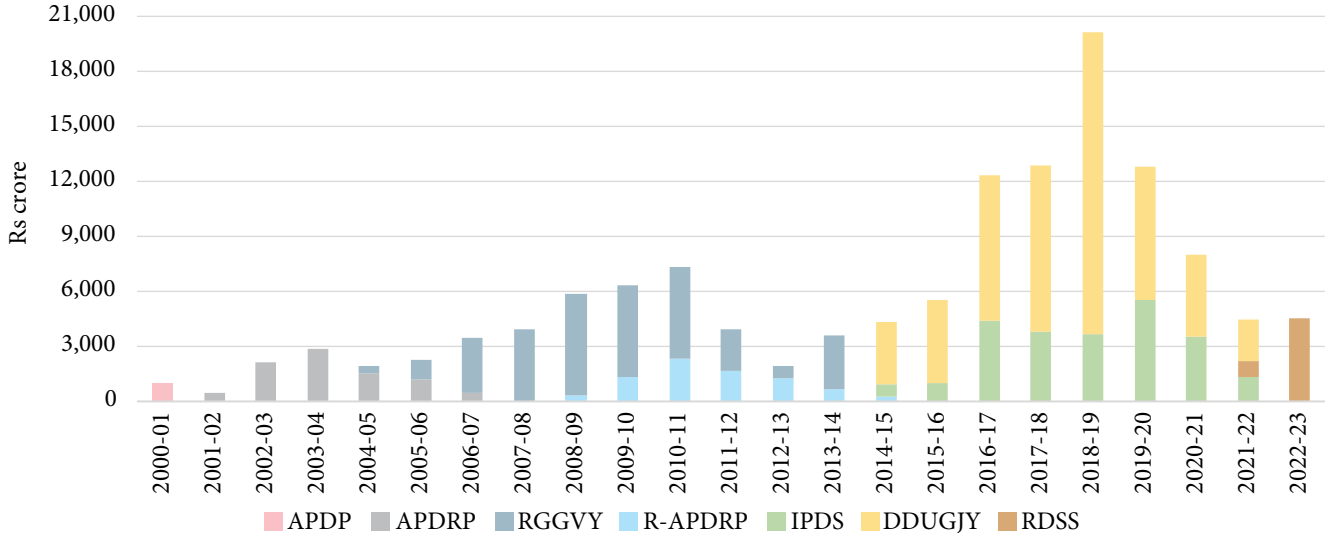

*Source:*

*a. Chapter IV under Part I of the 25th Report of the Standing Committee on Energy (2021-2022) on Demands for Grants for FY2022-2023 in respect of Ministry of Power, Government of India.*

*b. Chapter IV under Part I of the 35th Report of the Standing Committee on Energy (2022-2023) on Demands for Grants for FY2023-2024 in respect of Ministry of Power, Government of India.*

*Note: Actual utilisation for FY2024-2025 and FY2025-2026 and actual utilisation for FY2023-2024 onwards are not available.*

**Figure 8: Funds Released Under Various Central Government Schemes During FY2007-FY2022 in Rs crore**




*Sources: The author's analysis is based on the information available in the reports of the Parliamentary Standing Committee on Energy on Demands for Grants for FY2000-2001 up to FY2023-2024 along with their other reports on central government support schemes such as R-APDRP, RGGVY, etc.*

As such, the details of funds, State/DisCom-wise break-up of budgetary allocations vis-à-vis actual release of funds are not comprehensively available in the public domain. However, the difference between allocations and actual release can largely be attributed to the lack of absorption capacity of the DisComs. It is to be noted that State governments do not have the free cash to fund such high-level projects. These schemes supported by the Central government, are not financial bailouts but aimed at providing enormous financial support, enabling DisComs to achieve operational and performance objectives that DisComs would not be able to fund themselves.

However, it should be underscored that each one of the larger central government-funded schemes, cited above, is aimed at achieving multiple objectives. Objectives of each of these schemes include the reduction of AT&C losses as one of the main challenges to resolve. Conversely, other objectives listed in each of the schemes reasonably depend upon the reduction of losses by the distribution utilities.

Further, out of the two components of AT&C losses, funds are required to upgrade the network and thereby achieve billing loss reduction. Therefore, it may not be appropriate to consider that 100% of the funds under central government schemes are meant for billing loss reduction. However, a clear allocation of funds between different objectives is not available in the public domain.

## 5.4 Theft Reduction Through Effective Vigilance Mechanism

Pilferage of electricity is one of the key factors that adds to the billing loss and eventually to the overall AT&C losses. It is not just stealing electricity by laying bare hooks onto the transmission conductors but also unregistered consumers drawing of energy from distribution lines and poles, using electricity obtained under the subsidised consumer category for commercial purposes, etc. While measuring such loss remains a challenge, energy loss owing to different reasons falls into different buckets within the overall billing loss category.

There is another kind of pilferage due to using electricity under the wrong consumer category. For instance, loss of revenue due to usage of electricity for commercial purposes where the connection was originally obtained for consumption under a subsidised category (domestic or agriculture) falls into this category. Besides usage under the wrong category, losses also happen due to defective metering or meter tampering, etc. Pilferage owing to these reasons is not shown in energy accounts and is difficult to assess. This fraction of loss due to defective metering or meter tampering gets added to the collection losses and does not fall within the scope of this study.

The theft of electricity by directly hooking to the network or drawing of power through unofficially established connections is recorded under the billing loss segment. Only a fraction of actual theft under this route is caught by the enforcement agencies and levied penalties, whereas a significant part of total theft remains undetected. The energy loss under the theft category largely depends upon the component of theft that is left undetected. So, the larger question is whether it is possible to measure the total quantum of theft, including undetected theft. The answer is yes, but only under certain assumptions.

A specific amount of energy is lost due to inherent network inefficiency. Given the technical parameters of the network at different voltage levels, the normative loss can be calculated. If the actual loss exceeds the normative loss, there appears to be a loss due to non-technical reasons, which in other terms points towards pilferage. Therefore, the possible quantum of undetected theft is the difference between 'total billing loss (including detected theft)' and 'normative energy loss possibly owing to purely technical reasons'. Such loss due to undetected theft so calculated may not be accurate to the last digit, owing to assumptions considered. However, it gives a reasonable trajectory to understand the impact of theft on overall billing loss and the effect of loss mitigation measures taken by the DisCom.

The FoR, in their report on 'Loss Reduction Strategies', published a methodology to calculate theft (FoR, 2008). In this framework, the network is assumed to have lost energy differently at different voltage levels (i.e., 2.3% loss at 33 kV and above, 3.4% at 11 kV, and 8.7% at low tension network for the year FY2007-2008). However, it is observed that based on the voltage levels as indicated so far, it is possible that with the changing efficiency of the network, the loss values are expected to change. Hence, this paper does not include any further calculations or analysis on account of energy lost due to theft.

# 6. Analysis & Findings

## 6.1 Challenges in the Classification and Aggregation of Investments

The last decade and a half have witnessed ups and downs in annual billing loss levels across DisComs. However, considering the entire period of FY2006-2007 till FY2022-2023 as one segment and taking all DisComs as one group, a reasonable improvement in billing loss is observed. The same period also witnessed a flow of investments under 'R&M' and 'capex' towards maintenance, upgrading, augmenting, theft reduction, etc., at appropriate places.

R&M investment is essentially done by the DisComs within their budget, as approved by the regulator. In other words, R&M forms part of the annual expenditure of DisComs and is recovered from consumers through tariffs. The R&M is meant for the maintenance of distinct kinds of assets owned by the DisComs, and the maintenance of the distribution network gets subsumed in the overall R&M expenditure.

Even within the zone of maintenance of the distribution network, the money is spent on several activities, including repairs of the existing network, preventative maintenance, replacement of critical components, etc. It remains a challenge to assess the extent of activities that impact billing loss improvement. Thus, it leaves a plethora of options to identify the component of investment toward billing loss improvement vis-à-vis the actual improvement in billing loss. Therefore, identifying a single scenario to understand the efficacy of investment under R&M remains a challenge.

On the other hand, investment also happens through the route of capital expenditure. This consolidated capital expenditure kitty has multiple tributaries contributing to it. The capital expenditure includes funds from equity, borrowings, grants through various government schemes, loans converted to grants, etc. The information available in the public domain does not provide a breakup of capex with these details.

On the expenditure side, capex is used not only for upgrading the network to meet future growth but also to facilitate efficient distribution of electricity to meet current demand, new investments to improve quality of supply, renovation, and modernisation of the network, creation of support systems, new software and hardware, civil structures, etc. A fraction of these initiatives surely caters towards billing loss improvement. Unfortunately, the information in the public domain does not give much clarity about the money that is spent on billing loss improvement.

As regards information related to capex, PFC reports of earlier periods used to provide the same explicitly. However, the reports of recent periods do not directly provide the same. Therefore, the annual capex spending for those years is considered equivalent to

the change in the sum of 'Net Tangible Assets' and 'Capital Works in Progress' between two consecutive years. Also, the absence of a clear policy principle or regulatory indicator about the fraction of capex used for billing loss improvement led to the build-up of a set of scenarios considering different levels of capex spending towards billing loss improvement.

If we examine the issue of billing loss improvement from a different angle, the critical question is whether the entire billing loss improvement happened just because of the investments under R&M and capex or if any other factor helped it. Discussions with several experts in the electricity distribution domain led us to understand that apart from maintenance, repairs, augmentation, upgradation, etc. of the network, the staff on the ground play a critical role.

Effective vigilance, enforcement, and putting past learnings into practice, together significantly help the DisComs address the issue of billing losses. These vigilance and enforcement activities are not capital-intensive but reportedly yield favourable results. Unfortunately, details of money collected through vigilance and enforcement activities are not available in the public domain, leading to consideration of diverse levels of billing loss improvement owing to reasons other than investments.

Overall, the lack of granular data poses a greater challenge in assessing the quantum of investment either through R&M or capex towards billing loss mitigation and its efficacy. The efficiency of the distribution network is critical to ensure a seamless supply of power. Therefore, the efficiency of the network, i.e. supply of power while maintaining low billing losses, depends upon several factors such as the expanse of the distribution network, voltage levels of the network, age of the network, quality of its maintenance, etc., besides a host of other factors.

In addition to the above, consumer mix (HT and LT consumers), connected load, etc. also play a critical role, besides overall investment to maintain the network varies between DisComs. Owing to the opacity of data and the overwhelming impact of assumptions to be considered, it is observed that efficacy analysis may not be accurate enough to rely upon.

## 6.2 DisComs' Billing Loss Heterogeneity

In the context of the pan-India average billing loss of 13.28%, examination of billing losses across distribution utilities assumes importance. The overview indicates significant heterogeneity between different DisComs. As such, this heterogeneity is critical because the billing loss of one DisCom cannot offset the loss of another.

The billing losses of all DisComs (including power departments and private DisComs) in FY2022-2023 indicate a wide range, i.e. 0.93% to 44.03%. The billing losses of government DisComs fall within a range of 1.63% to 30.28%; amongst them, 16 DisComs carry less than 10% billing losses. In the private sector, out of a total of 14 Discoms, the range is between 1.62% and 24.96%. In the private sector, except for the four recently privatised Odisha DisComs, the rest all recorded a billing loss of less than 10%. In the power department space, out of 10 utilities, only Goa has shown a great loss level of 0.93%. Except for Puducherry and Andaman & Nicobar Islands (which have a loss of less than 20%), the rest all have exceeded 20%, touching as high as 44.03% (Arunachal Pradesh).

We note that the AT&C losses are disproportionately high in power departments located in Union Territories, the North-east or in hilly regions. *However, strong generalisations are difficult because of the heterogeneity across DisComs.* This suggests that heterogeneity is essentially due to certain inherent reasons specific to the DisComs, besides a host of commonly identifiable causes, such as quality of legacy network, interplay between annual capital spending, and upgrading of network to mitigate billing losses, network maintenance, nature of geophysical terrain, length of rural feeders, etc. *Therefore, it becomes essential to consider the heterogeneity of positives and negatives across DisComs. This also emphasises the fact that one size does not fit all when it comes to solutions.*

**Table 1: Billing Loss Heterogeneity of DisComs Across Different Ownership Categories (FY2022-2023)**

| Ownership Category | No. of Distribution Utilities | Billing Loss Range (%) |
|---|---|---|
| Power Departments | 8* | 0.93 (Goa PD)–<br>44.03 (Arunachal Pradesh PD) |
| Privately Owned | 14 | 11.62 (Dadra Nagar Haveli)–<br>24.96 (Tata Power Southern Odisha Distribution) |
| State Government Owned | 46 | 1.63 (Dakshin Gujarat)–<br>30.28 (Jharkhand) |

*Source: Authors' analysis using data from PFC Report on Performance of Distribution Utilities for FY2022-2023.*

*Notes: *Information related to three power departments, i.e., Chandigarh PD, Jammu and Kashmir PD, and Lakshadweep ED, are not available and Odisha was only recently privatised.*

Irrespective of the ownership category, we find many DisComs that have shown exceptionally competitive loss levels. Similarly, we find a host of utilities have recorded very poor performance across different ownership categories. One important question becomes not just who had high vs low losses but their trends.

If we consider the progress, it took around 17 years to reach a 13.3% loss level (FY2023) from 26.2% (FY2007), i.e., improving at a CAGR of around 4.1%. At present, the current level still falls short of the normative mark of 12.6%. The best utility had a loss of 0.93%, while the average of the best five government DisComs/Departments (in terms of billing losses) came to around 3.91%. This drives an important point that government DisComs carry a significant scope for improving upon their billing losses from the current levels.

While the current level of poor billing loss is well known, the question remains: how long can they continue to go by the current trajectory? What would it take to determine a more competitive billing loss trajectory by the regulator? What should they do to bring them to catch up with the specified trajectory? More critically, what are the financial gains that can accrue to the system?

## 6.3 Scope for Improvement in DisComs' Billing Losses

First, given the heterogeneity across DisComs in terms of billing loss targets as well as loss level achievement, there appears to be a significant scope for improvement in terms of determination of loss trajectory. Before we jump to conclusions, we need to understand, what this loss trajectory means in rupee terms and what happens if DisComs under-achieve or over-achieve their loss targets.

Fundamentally, billing loss improvement facilitates reduction in power procurement costs of DisComs. In simple terms, when the DisCom reduces its power loss in the network, it results in lesser procurement to that extent. This further results in reduced revenue requirement in the tariff petition and that reflects as lesser tariff for end consumers. So, DisCom's achieved billing loss gets amalgamated into calculation of AT&C loss. This achieved AT&C loss is compared with the normative mark and any under-achievement is considered as business loss to the DisCom, and benefits owing to over-achievement are shared between consumers and DisComs in equal ratio.

Second, what would it take to determine a more competitive billing loss trajectory by the regulator? Often the regulator determines a singular AT&C loss trajectory which factors in both billing losses and collection losses. Only in a handful of cases are separate trajectories for billing losses and collection losses indicated in the tariff orders. This leaves an ambiguity, leading DisComs to draw their own conclusions about the balance between billing losses and collection losses.

Therefore, in order to tighten the billing losses a level above, the regulators have to draw clear lines between the billing and collection loss trajectories. In the future, such distinction facilitates the regulators to do a deep-dive analysis of high loss-making areas and then suggest corrective measures to the DisComs to bring improvements in those areas of operation.

Finally, coming to the expected financial gains in the event of achieving a specific level of billing losses, it needs to be seen through different lenses: what if the same rate of improvement is adhered to? Or what if a more aggressive approach is adopted? Or whether any mid-way can be trodden?

Given the current billing loss target, i.e., 12.6% (FY2023), and if the same rate of change in target determination is continued, by FY2033 under 'base case' scenario, the billing loss target could be approximately 8.1%. From the current loss mark of 13.3% in FY2023, they are likely to reach the mark of 8.7%, provided DisComs continue to adhere to the same rate of improvement, i.e. 4.1%. So, same rate of progress would still keep the target away and falling short of target would still leave a hole in DisCom's pocket. This calls for a more aggressive approach.

In this paper we consider four scenarios based on the billing loss level aimed to achieve by FY2033. The most daunting task could be to take the pan-India average (government utilities only) to touch the current average of top five utilities in terms of their billing losses, which comes to 3.9%. This can be achieved only if the loss is improved at an average rate of 11.5%. The other end of the spectrum is the business-as-usual case, i.e. to reach the level of 8.7%. In between, this paper also explored the target billing loss levels of 8%, 7%, 6%, and 5%.

Under each case, the additional loss improvement beyond the base case level is identified to arrive at the additional gains in energy terms and subsequently in rupee terms. However, before calculating the additional savings, the growth in energy procurement and power purchase cost are considered to grow at an average rate of 5.4% and 5.17% respectively, matching with their growth rate over the last 17 years.

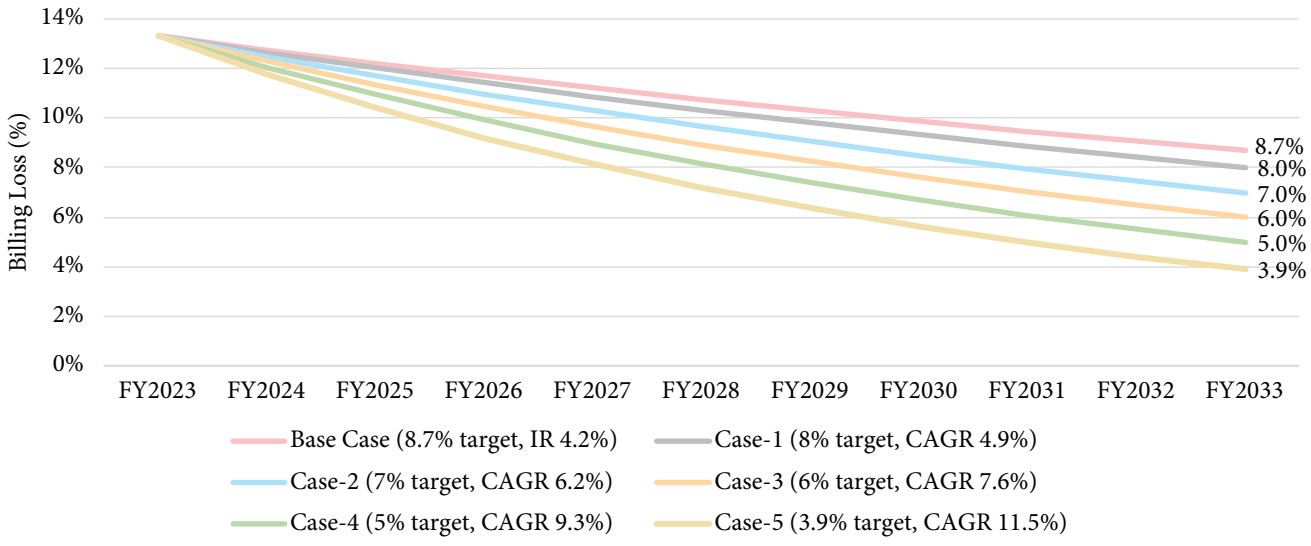
With reference to the base case (this being the reference point), the rest of the five cases (aimed at achieving projected targets) show varied levels of saving in terms of energy as well as power purchase costs; however, higher the target, better the saving. As the loss level improves year-on-year, its impact on overall power procurement is visible.

**Table 2: Billing Loss Targets and Desired CAGR to Achieve**

| | Current Billing Loss (FY2023) | Target Billing Loss (FY2033) | Desired CAGR Rate of Improvement (relative improvement) |
|---|---|---|---|
| Base Case | 13.3% | 8.7% | 4.2% |
| Case-1 | 13.3% | 8.0% | 4.9% |
| Case-2 | 13.3% | 7.0% | 6.2% |
| Case-3 | 13.3% | 6.0% | 7.6% |
| Case-4 | 13.3% | 5.0% | 9.3% |
| Case-5 | 13.3% | 3.9% | 11.5% |

*Source: Author's calculations based on data from PFC Report on Performance of Distribution Utilities for FY2022-2023.*

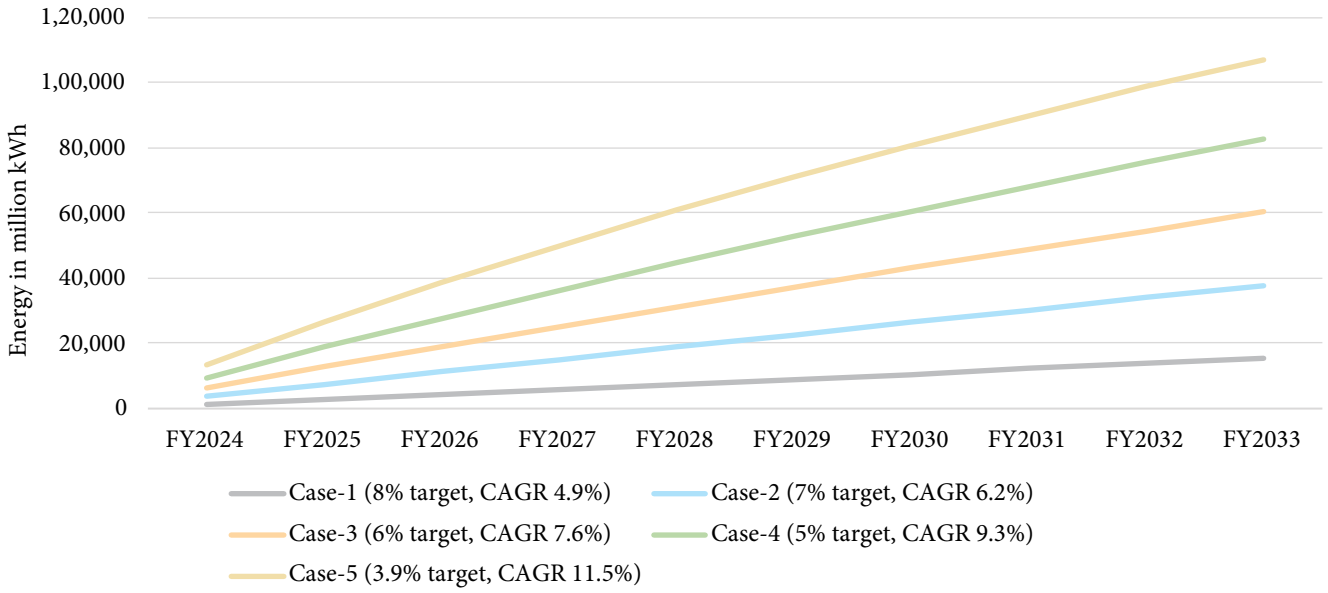
**Figure 9: Billing Loss Reduction Trajectory to Reach Different Targets in FY2033**




*Source: Author's calculations based on data from PFC Report on Performance of Distribution Utilities for FY2022-2023.*

*Notes: All cases projected above are expected to start from the same point of billing loss, i.e. 13.3% (FY2023). Each case is projected to follow a specific improvement rate (IR) to reach the target level by FY2033.*

**Figure 10: Projected Energy Savings Under Different Billing Loss Targets in FY2033**




*Source: Author's calculations based on data from PFC Report on Performance of Distribution Utilities for FY2022-2023.*

Considering all cases by the end of FY2033, the savings in rupee terms could be anywhere between Rs 14,160 crore to Rs 97,845 crore. This saving, if reflected as a reduction in overall revenue requirement of DisComs, indicates a possible reduction in tariff in the range of 7 paise to 50 paise per kWh sold by FY2033. However, the DisComs need not wait till FY2033 to see the above results. The impact of billing loss improvement would reduce the tariff requirement in the range of 1 paise to 7 paise per kWh in the first year, i.e. FY2024 itself.

In cumulative terms, over the 10-year target period (i.e. FY2024 through FY2033), the DisComs, upon achieving the targets (under different scenarios), would save anywhere between 83.6 billion kWh and 637 billion kWh. This translates into a monetary saving in the range of Rs 66,348 crore to Rs 5,00,666 crore, which factors in the growth of power procurement quantum as well as costs.

At a macro level, the billing loss in FY2023 seems to be reasonably good as it approaches the normative level. However, in comparison to the better-performing government DisComs, there appears to be ample scope to improve beyond the normative mark, i.e. from the existing 12.6% to 6%.

Performance in terms of billing loss improvement of a DisCom depends on two critical factors: quantum of investment and initial level of billing loss. The effort to bring down the loss level varies considering its initial loss level. Conventional wisdom suggests a saturation effect, meaning the relative bang-for-buck of an investment will decline as losses improve. We further explore this concept.

Having seen the highly positive impact in terms of energy as well as reduction in revenue requirement, the focus would naturally shift to investments that can actually bring such results. The critical questions would be: what is the investment required for achieving a 1% improvement in billing losses, and what is the break-even period of that investment? So far, the investments have been made in two specific channels, i.e. repairs and maintenance of the network and capital investment for upgradation and augmentation of the network.

Under these two streams, several initiatives are undertaken, but it is quite difficult to identify those line items which brought a positive impact on billing losses. This leads to the assumption of several parameters and then calculation of the investments made so far to project future requirements. This would further be considered to analyse the efficacy of the investments. In these cases, due to the non-availability of a clear break-down of investments, overwhelming dependence on assumptions is warranted. Under these circumstances, the above issues are considered for a detailed study separately.

# 7. Policy Implications & Recommendations

The issue of billing losses has been hanging fire over the last two decades, more so since the promulgation of the Electricity Act, 2003. Taking a cue from the provisions under the Act, different stakeholders—be they regulators, policymakers, or utilities—have been making efforts to contain the losses. While regulators are managing the responsibility of determining normative losses and providing regulatory oversight on the progress made, utilities are working towards effectively utilising the R&M budget. On the other hand, policymakers, particularly the Central government, have been infusing money through different schemes designed with a specific set of objectives. Billing loss improvement has invariably been included as one of the critical objectives in most of these schemes over this period.

Apart from the above, utilities spend significant amounts on capital expenditure, the objectives of which also include billing loss improvement. Of course, the specific fraction of money spent on billing loss mitigation measures is not easily identifiable. The capex is based on money from different channels, including a fraction of equity, borrowings from government, borrowings from banks and financial institutions, grants under various government schemes, and loans provided under government schemes which later get converted to grants.

The billing losses (as a fraction of total input energy) have also improved moderately; however, for the most part, they are not better than the normative levels specified by the regulators. Given the efforts of multiple agencies towards the mitigation of billing losses and the loss improvement achieved so far, it calls for a fair analysis of the efficacy of investments. The previous sections have analysed these factors and have led to the following policy implications and recommendations for the relevant stakeholders.

## 7.1 Splitting of AT&C Loss Targets and Tightening the Same

As Devaguptapu & Tongia (2023) pointed out, there is an urgent requirement for explicitly breaking down the composite measure of AT&C into separate trajectories of billing and collection losses. In addition, a separate measure of energy loss on account of theft should also be considered, along with specific targets for theft reduction.

Considering the billing loss improvements vis-à-vis quality of equipment installed, efficiency of manpower, regulatory support, and a host of other enabling conditions, there appears to be greater scope for achieving better results. In support of this argument, one can consider that several public sector DisComs have easily achieved billing losses of less than 10%. This calls for further tightening of the target loss levels. Reduced billing losses result in lowering consumer costs, even if they don't help DisComs liquidate their accumulated losses. Of course, given the network (physical) constraints, urban areas should be given tighter targets, in comparison to rural areas that have longer lines.

For effective loss management, regulators should ideally monitor losses at feeder level and subsequently at the level of distribution transformer. This calls for regulators to explore the possibility of determining DT-wise loss targets as well. The Central Government is starting efforts for centralised monitoring of feeders and, subsequently, distribution transformers. This will go a long way in measuring the actual performance of both operations and investments. Ideally, investments should also map to the same level of granularity, e.g., what was spent on strengthening the network, where, etc. There should, similarly, be breakdowns on what particular government support went towards, while the worst-case scenario would be if money meant for loss reduction ended up being spent for financial liquidity reasons.

Accelerating distribution transformer metering (with real-time or near-real-time data) will also help fill the gap created by the lack of meters for agricultural pumps. Taken together, DisComs and policymakers need to quantify a trajectory for theft separately. By definition, this is not easy because kilowatt-hour losses are a combination of technical and theft losses. Nonetheless, improved metering and data online uploading with granularity will help reduce the uncertainty significantly. This will then provide feedback on where and in what form capital investments will give the greatest bang for the buck; for example, the current policies geared towards changing distribution lines from naked wires to aerial bunched cables (ABC), which minimise the risks of consumers hooking and stealing power.

It remains a separate analysis as to what is an optimal investment level, and who or what source should fund such investments. It is good that the Central government is supporting DisComs given precarious state finances, but it is also reflective of the larger malaise that such help is perennially required.

## 7.2 Customised Investment Aimed at Effective Billing Loss Mitigation

Mitigation of billing losses requires investments, and DisComs, with their limited resources, cannot address the issue comprehensively in one go. Therefore, DisComs deserve complementary support through a national-level framework. Such complementary support for the mitigation of billing loss is often included as a regular component in the bigger central government support frameworks.

But, as discussed, billing losses carry many strands, each one of which needs to be addressed in a specific way. A standardised method of providing normative financial support, refinancing, and provisioning of loans with an option to convert them into grants subject to meeting certain targets, sounds reasonable but works only if the problem is similar across all DisComs. However, in this case, the initial level of billing loss, the quality and vintage of the distribution network, and the cost components that determine the loss in rupee terms, vary between DisComs. Hence, the cause(s) of the problem and the final financial impact of billing loss excesses differ for each DisCom.

Generally, it is held that a relatively lower investment is required to improve the losses of DisComs with higher initial loss values. This may not be true in all cases and calls for a detailed analysis of loss improvements over longer periods vis-à-vis their initial loss levels and the investments made during the period. However, given the heterogeneity amongst the DisComs in terms of the current billing losses, and rate of improvement over the last two cycles of multi-year-tariff cycles (if not longer), customised solutions need to be identified for capital investments. Apart from this, we need to further study the causes of heterogeneity after normalising for the initial loss level so that best practices can be applied elsewhere.

## 7.3 Need for Granular Data in Public Domain

It is widely observed that a lack of consistent data has remained a primary challenge for analysis over the last two decades. In other words, duly audited granular regulatory-grade data across different segments of the electricity business is highly desired by policymakers, regulatory practitioners, and researchers alike.

Even in the context of the current study, the granularity of data is crucial to better understand the evolution of each sub-component of the larger AT&C loss figure and their eventual impact on the overall financial health of the distribution utilities. In this case, within billing losses (which span both technical losses and theft), there are multiple components, including energy lost in the lines (due to technical losses), direct theft, supply to un-metered connections, improper reading (or not reading at all) of meters, faulty meters, and meter tampering, which form part of the total AT&C loss.

However, granular data under each sub-head is not available, which causes the decision-makers to resort to calculating the loss under certain assumptions. On the one hand, the assumed values may not be closer to the actual loss and, on the other, the corresponding corrective measures against each sub-component of loss may also remain ineffective.

Therefore, data should be more granular with necessary breakdowns. Of late, there have been certain initiatives by Power Finance Cooperation (PFC), REC, NITI Aayog, CEA, etc. in providing data. Besides, DisComs also provide layers of data as part of their Annual Revenue Requirement (ARR) petitions submitted to the respective state regulators. Although these initiatives are laudable, they are not sufficient to portray the complete picture of the sector. The data that is currently available achieves the goal of providing a macro-level loss figure under certain assumptions.

In addition to data on all the above components or causes of billing losses, there needs to be spatially granular data. If a DisCom has, say, 20% billing losses in total, the geographic spread or concentration is critical to identify the true loss-making areas, initiatives taken to arrest those losses, the efficacy of such initiatives, and designing future action plans. Similarly, substantial funds are invested in revamping the existing metering infrastructure to install smart meters. Unless the loss due to 'defective meters' or 'improper meter reading' is available, the economic evaluation of such investment depends upon certain assumed numbers, and the final measure of the efficacy of such infrastructure may not provide the real picture.

## 7.4 Energy Auditing

Even before we discuss the efficacy of investments in bringing down the billing losses, we should ideally know what the actual billing losses are. In this process, multiple challenges emerge. Apart from the

challenge of getting consistent data, flawed measurement of energy flows stands as an important contributor to the emergence of inconsistencies in data. Ideally, energy input and output should be measured at multiple points in the distribution network, right from the point of the DisCom periphery up to the tail end of the feeder level.[2]

Measured flows at different points of the network help effectively calculate the billing as well as collection losses. Further, measurement accuracy is also critical to the final result.

It is generally understood that specifications of the network, including connected equipment, provide a reasonable measure of energy loss, whereas the measure of loss on all other counts is arrived at under assumptions. In this scenario, energy audit facilitates an accurate assessment of the losses under different segments as part of the overall AT&C loss figures.

For instance, in the majority of DisComs, a good part of the energy consumed by agricultural consumers is not metered, leaving a gaping hole in the measurement of AT&C losses. Fundamentally, an energy audit is a process used to accurately measure the loss by carrying out proper measurement of input and output of energy at different crucial points in the network. Such structured measurement facilitates identifying the loss-occurrence areas, which further enables the formulation and introduction of appropriate frameworks to arrest those losses.

The energy audit essentially involves the installation of meters at all appropriate points and measurement of energy received from each 11 kV substation for all the outgoing feeders, thereby arriving at the actual quantity of energy input to each feeder for each period, say monthly. The monthly energy sales to all consumers connected to the specific feeder are summed up and compared with the energy input measure, to find the difference between the input and sales. This difference, which indicates the billing loss, includes energy lost due to pilferage, non-metering, faulty metering, etc. in addition to the loss due to technical reasons.

The cumulative AT&C loss in rupee terms for 17 years from FY2006-2007 onwards is around Rs 15 lakh crore, while for FY2021-2022 alone it is approximately Rs 1.12 lakh crore, which is non-trivial. Considering the volume of these losses, it would be inappropriate to think about the financial turnaround of DisComs without addressing the issue of AT&C losses. Thus, the highly warranted corrective action needs to start with energy audits. Given the criticality of energy audit, it should result in substantial savings for DisComs along with higher revenue earnings.

## 7.5 Criticality of Theft Control

Billing loss incurred in the network includes electricity pilferage. The Electricity Act, 2003 extensively discussed theft control, and further provided for the establishment of special courts to deal with theft cases. This is undoubtedly a critical initiative towards the effective resolution of incidents of theft. However, the prevention of theft is more critical to the reduction of overall billing loss.

Theft happens through various routes, including but not limited to laying hooks to the bare transmission conductors, unofficially taking supply from distribution lines and poles, subverting the meter, tampering with the meter, faulty meter reading, etc. In addition to these routes which fall under billing losses (measured in kWh), there can also be theft via other routes, e.g., using electricity obtained under a subsidised consumer category for commercial purposes. Only a fraction of actual theft under this route is likely to be caught by the enforcement agencies and levied penalties. So, the question remains 'What component of theft is left undetected' and how can it be arrested?

Although formulation and subsequent notification of regulations regarding handling theft cases is necessary, they are not sufficient to reduce theft. The regulations should also identify the loss under the theft category and provide a loss improvement trajectory. In continuation, the annual revenue requirement should include a budget sub-head specifically to address theft mitigation.

Improved metering and data on energy input vs energy billed with consumer category level granu-

[2] DisComs buy power via transmission companies, which hand over power to a sub-station at a higher voltage. DisComs may have additional substations en route, but in all cases, they convert the power into medium voltage (typically 11 kV) feeders, which emanate radially from sub-stations. These then have multiple DTs, which convert the 11 kV lines into LT (low-tension) lines, which provide retail levels of voltage (220 volts for single-phase users). The final handover is at the consumer's meter, at the boundary of the consumer's domain.

larity will help better understand sub-components of billing loss. Undoubtedly, further acceleration of DT metering also facilitates monitoring of all such un-metered supplies, i.e., agricultural pumps. In a nutshell, there is a need for determination of separate trajectories for theft improvement. This forms critical input for identifying the areas where greater efficiency can be achieved for capital investments, for example, the current policies geared towards changing distribution lines from naked wires to ABC, which minimise the risks of consumers hooking and stealing power.

The alternative is underground cabling, which is much more expensive and typically deployed only in selected urban areas where space or rights of way can also be a concern.

In addition to the continued efforts of DisComs, the regulations should ideally recognise and include the central government assistance through various schemes such as pre-paid smart meters under RDSS in their regulations and ARR orders.

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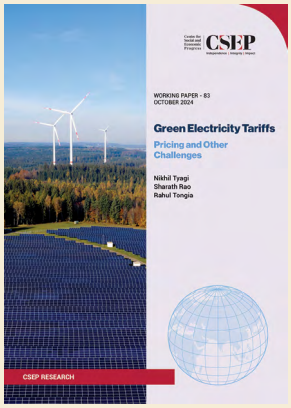
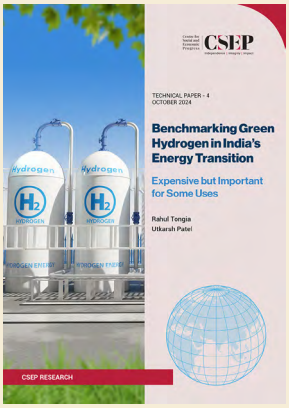
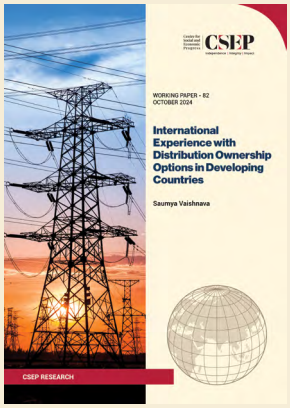
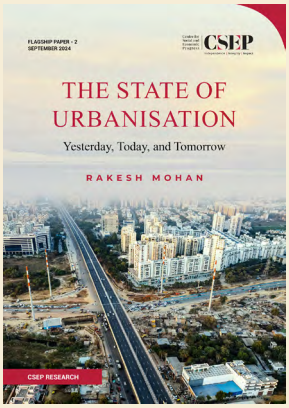
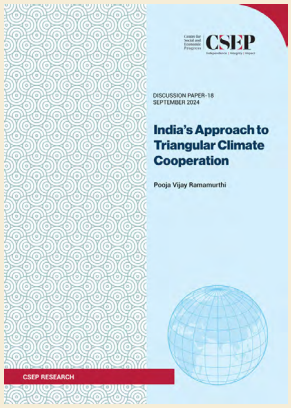
# Other publications

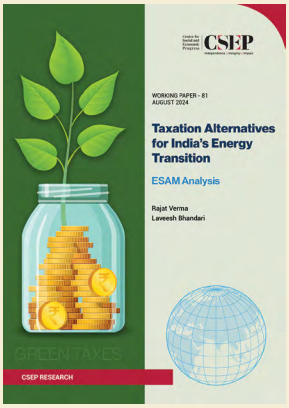


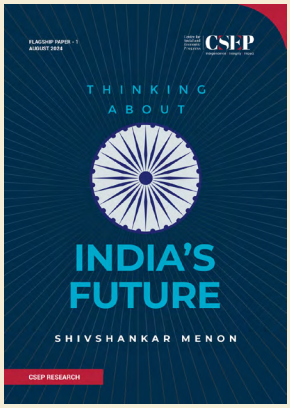



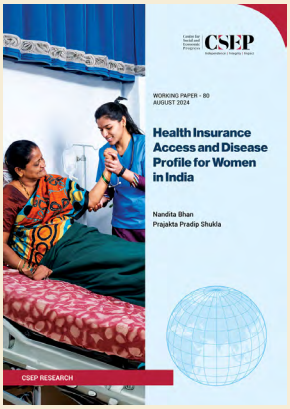



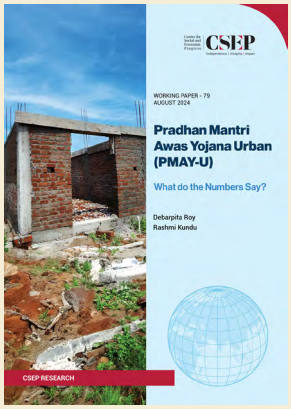



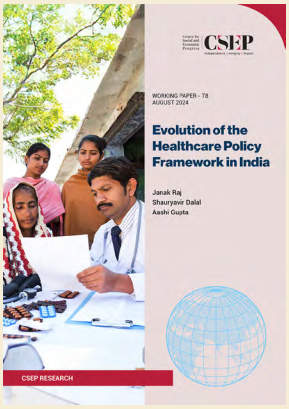



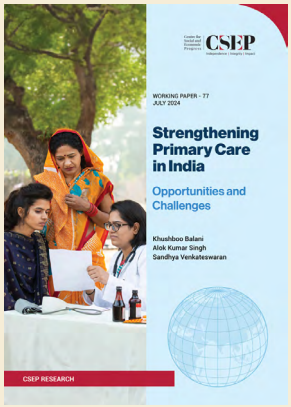



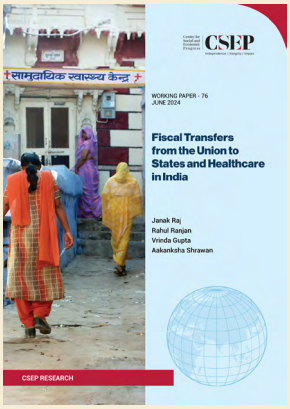



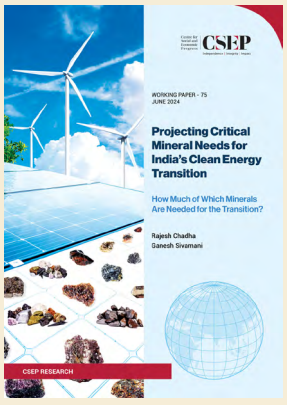



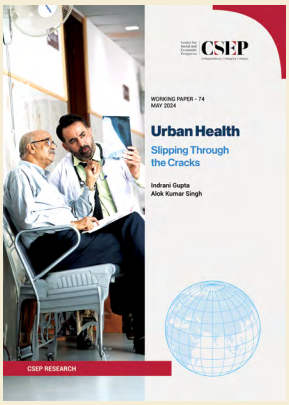



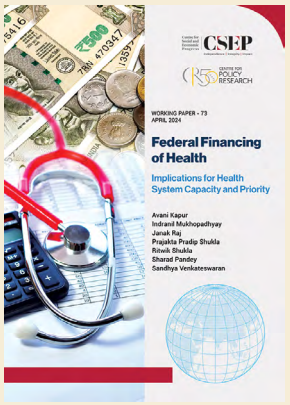



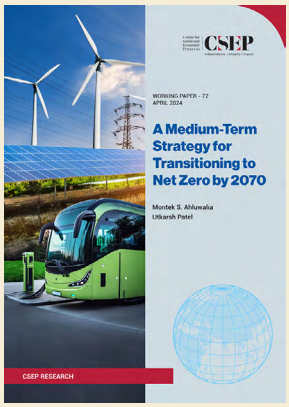

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