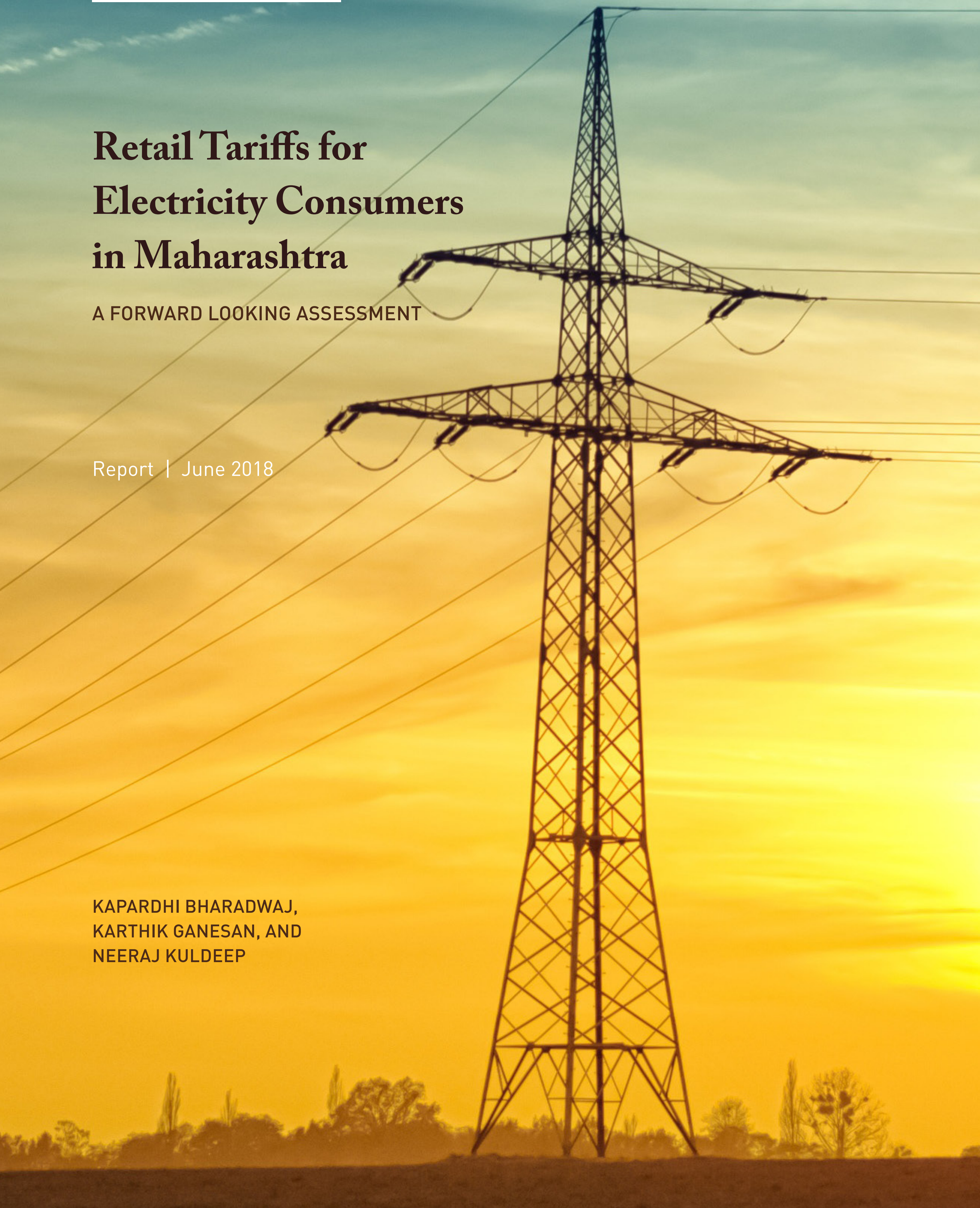

THE COUNCIL

Retail Tariffs for Electricity Consumers in Maharashtra

A FORWARD LOOKING ASSESSMENT

Report | June 2018

KAPARDHI BHARADWAJ,
KARTHIK GANESAN, AND
NEERAJ KULDEEP

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A report on 'Retail Tariffs for Electricity Consumers in Maharashtra: A Forward Looking Assessment'

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Neeraj Kuldeep is a Programme Associate at CEEW. As part of the Renewable Energy (RE) team, he has researched and published multiple policy briefs on the impact of Goods and Services Tax (GST) on RE, skill gaps in the solar and wind energy segment, assessing employment potential in the renewable energy market, applications and economics of energy storage technologies, long-term view on grid electricity tariffs, etc.

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Abbreviations

ABR	average billing rate
ACoS	average cost of supply
ARR	annual revenue requirements
BEST	Brihanmumbai Electric Supply & Transport Undertaking
C&I	Commercial & Industrial
CAGR	compound annual growth rate
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
DISCOM	distribution company
FY	financial year
GW	gigawatts
HT	high tension
LNG	liquified natural gas
LT	low tension
MERC	Maharashtra Electricity Regulatory Commission
MNRE	Ministry of New and Renewable Energy
MSEDCL	Maharashtra State Electricity Distribution Company Limited
MSETCL	Maharashtra State Electricity Transmission Company Limited
MSPGCL	Maharashtra State Power Generation Company Limited
MU	million units
MYT	multi year tariff
NPCIL	Nuclear Power Corporation of India Limited
NTPC	National Thermal Power Corporation
O&M	operations & maintenance
PPA	power purchase agreements
RE	renewable energy
RIL-D	Reliance Industries Limited - Distribution
ROE	return on equity
SLDC	State Load Despatch Centre
T&D	transmission and distribution
TPC-D	Tata Power Company Limited - Distribution

Executive Summary

Estimating the future cost of electricity requires an understanding of the different components of an electricity bill, the regulatory procedures and influences that impact the tariff for each of these components, and the market and political forces that affect these tariffs. Each component of an electricity bill is determined by a variety of factors. To provide clarity on the make-up of power supply costs, the overall cost is broken down into four parts: power procurement costs, transmission charges, distribution charges, and cross-subsidy charges. Should there be more clarity (in due course) on the specific trends for each part, the forward-looking trends can be fine-tuned accordingly.

The four components of an electricity bill and the factors that influence them are as follows:

- **Power procurement costs:** The cost to generate power is driven by the overall mix of generation, the cost of fuel for each generation source, the efficiency of these generators, and the capital and operational costs of each generator. The cost of integration of renewable energy has been considered as part of the power purchase costs in this analysis. These costs are taken from CEEW's long-term (mid-century) projections for India based on the results of energy modelling (CEEW, 2017). In addition, this component also accounts for (technical) losses incurred in transmission and distribution.
- **Transmission charges:** The cost to transport high-voltage power from the generators over inter-state and intra-state lines to the DISCOM infrastructure. This is driven by the cost of building and maintaining these lines as India's need for electricity grows.
- **Distribution charges:** The cost to distribute and transform, from higher to lower voltages, the power from transmission lines to individual customers. This is driven by the cost to build and maintain the infrastructure to deliver power and to comply with the Renewable Power Purchase Obligations for each state.
- **Cross-subsidy charges:** The cost for commercial and industrial customers to offset the total delivered cost of electricity to domestic customers. This is driven by political considerations and dynamics in each state.

This report examines each of these factors in detail. In order to present the relative influence of different factors, this report has considered two scenarios, with varying energy mixes based on RE capacity additions and based on certain expectations regarding changes in cross-subsidy, which is an inherent part of the power sector. The two scenarios-high RE penetration and low RE penetration-are both conservative estimates of planned RE capacity additions, going by the ambitions expressed by the current government. The costs of integration have been arrived at on the basis of discussions with various stakeholders, including MNRE officials, experts on grid integration, and other researchers working on RE-integration costs. Adani Transmission Ltd has acquired the Mumbai business of Reliance Industries (RIL) (TOI, 2017). Any mention of RIL-D hereby refers to the distribution business owned by Adani Transmission Ltd.

Transmission charges will rise as per the investments made in the overall network (inter-state as well as intra-state). The estimations, however, look at the growth trends projected in the latest Multi Year Tariff (MYT) orders of all four DISCOMs, and the same are projected on transmission charges, looking ahead.

Distribution charges, based on the operating expenses of a DISCOM, are a complex mix of administrative and O&M expenses, capital expenditure, and employee expenses. For the purposes of this study, operating expenses of DISCOMs (distribution charges) have been assumed to constitute a fixed ratio of the overall cost of supply. This represents the upper limit of the range of values seen in the DISCOMs that operate in Delhi.

The cross-subsidy component can have a telling impact on future tariffs. Extensive review of tariff orders provides no insight into the science of cross-subsidy determination. However, policy makers acknowledge that reduction of cross-subsidies (across consumer categories) is one of the major drivers of regulatory reforms. This constitutes a significant assumption in this assessment and is considered in parallel with the scenarios that depict two different energy mixes. The ratio of the average billing rate for a consumer category (ABR) to the overall average cost of supply (ACoS) is an indicator of tariff rationalisation for that category of consumers. Going forward, some rationalisation is expected in both the scenarios.

Apart from standard tariff components, the Mumbai DISCOMs also pay standby charges to Maharashtra State Electricity Distribution Company Ltd (MSEDCL) to ensure reliable and uninterrupted supply to Mumbai consumers. Standby power capacity is equivalent to the largest power generating unit, 500 MW, supplied to Mumbai city. It is essential to have standby power for reliable supply in the event of failure of any generating unit that is supplying to Mumbai.

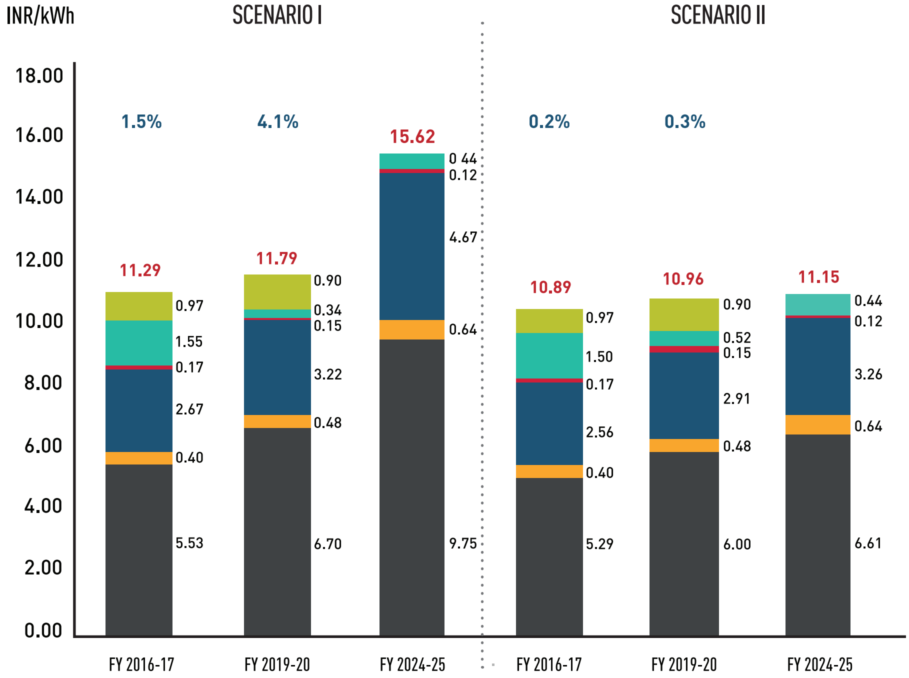
Observations

A base case scenario for MSEDCL is considered assuming that the future energy mix will be the same as the current mix and that the cross-subsidy remains the same, going forward. In the case of the Mumbai DISCOMs, a base case was not considered because the cross-subsidy charges are relatively low when compared to those of MSEDCL. There is little difference in the existing energy mix in scenario I, which was the premise for not including a base case for the Mumbai DISCOMs. There is uncertainty about the energy mix and the procurement costs for the Mumbai DISCOMs because of transmission constraints in bringing power into Mumbai (discussed in detail in Chapter 3). Scenario I assumes that the existing energy mix will continue in view of the transmission constraints for Mumbai remaining unresolved. Scenario II assumes that the transmission issues have been resolved, and that the DISCOMs can procure from any power plant in the grid, and as a result, a higher share of RE is envisioned, which is in line with the national ambitions of achieving higher RE penetration.

Power procurement costs continue to constitute the largest share of the cost of supply

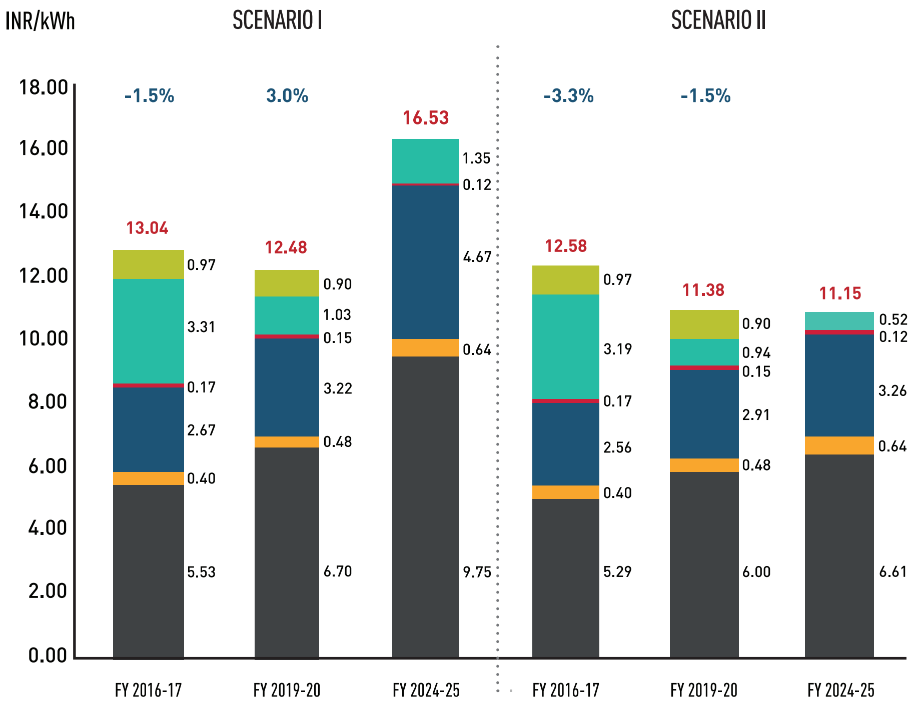
Power procurement costs continue to constitute the largest share of the cost of supply. The illustration below presents the share of components in future tariffs for high tension (HT) commercial and industrial consumers of RIL-D.

ABR for industrial consumers of RIL-D

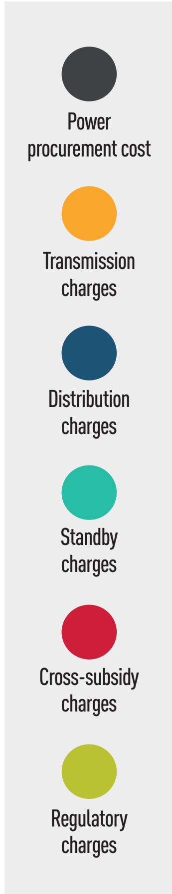


Source: CEEW estimates

ABR for commercial consumers of RIL-D

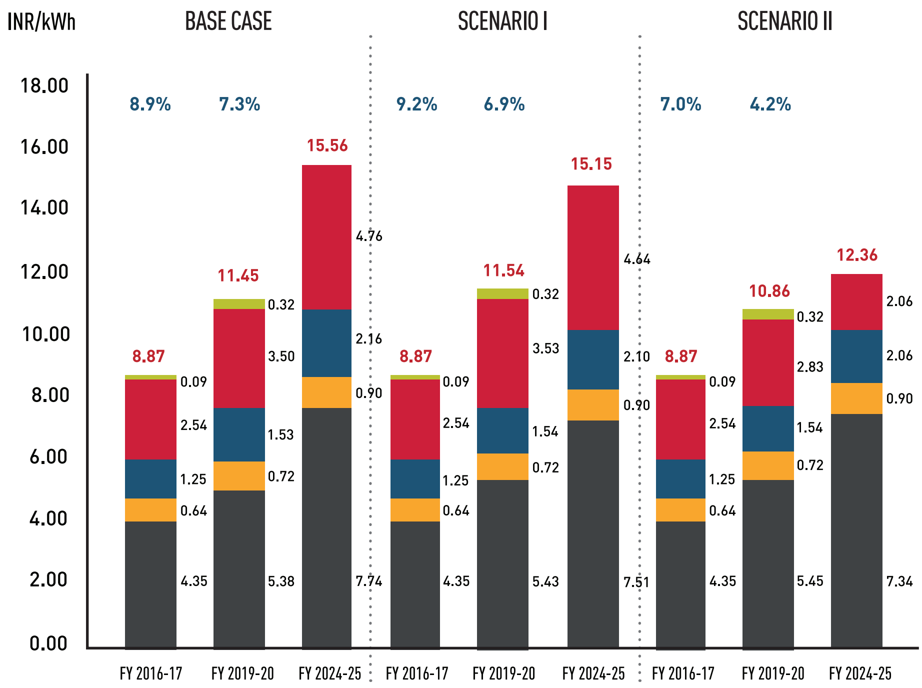


Source: CEEW estimates

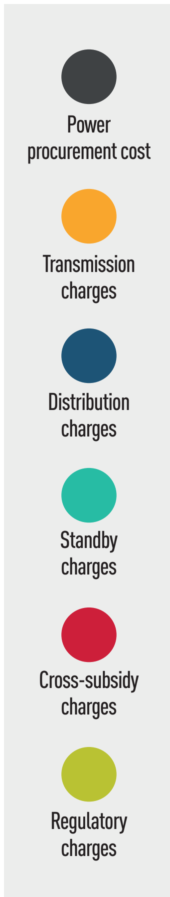


Similarly, the cost of distribution for commercial and industrial consumers of MSEDCL is detailed in the two illustrations below.

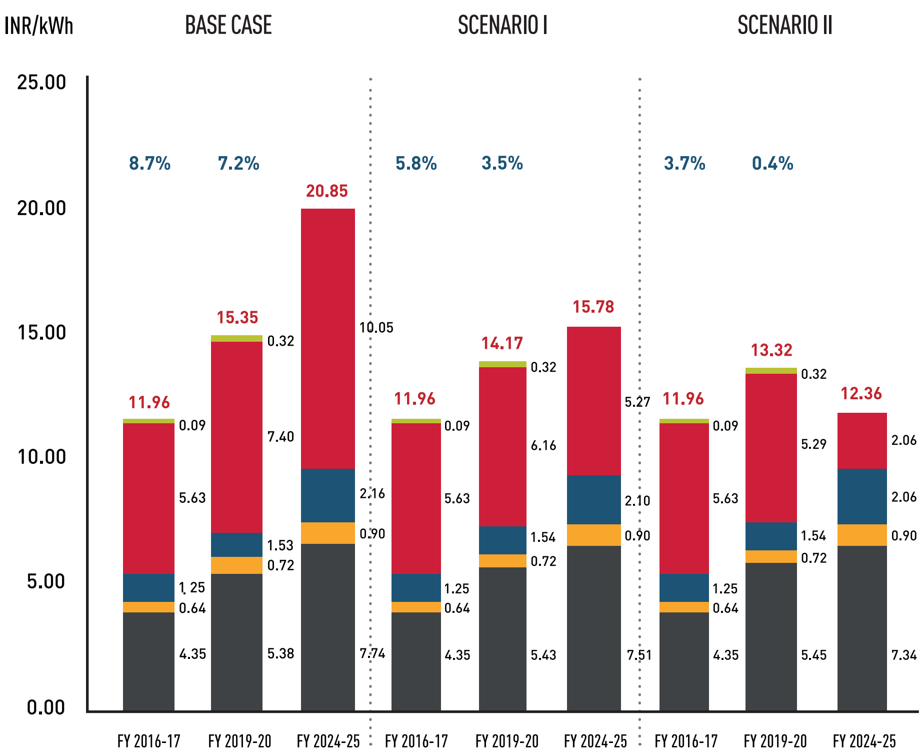
ABR for industrial consumers of MSEDCL



Source: CEEW estimations based on indicated assumptions



ABR for commercial consumers of MSEDCL



Source: CEEW estimations based on indicated assumptions

Power procurement cost is dictated by the rate of growth of the energy charges associated with the various sources of electricity. The future tariff for commercial and industrial consumers will depend largely on three main parameters - the energy mix, the cost associated with each source, and cross-subsidy and regulatory asset charges. This is highlighted in two scenarios presented for RIL-D, and in three scenarios presented for MSEDCL. The higher share of renewable power in the overall energy mix limits the growth in power procurement cost, as a portion of costlier coal power is replaced with cheaper renewable power in the future.[1] The estimates (for commercial and industrial [C&I] tariff) in the base case scenario for MSEDCL are at the higher end of the three scenarios considered.

Higher share of renewable power in the overall energy mix limits the growth in power procurement cost

Cross-subsidy will also have a significant impact on the overall tariff for C&I consumers. As per the guidelines from central and state regulators, tariff for C&I consumers is expected to be within +/- 20 per cent of ACoS. Currently, commercial consumers in Maharashtra (excluding Mumbai) are paying as much as 200 per cent over and above ACoS. Rationalisation of cross-subsidy for C&I consumers will take place. However, it is difficult to commit a time frame for the achievement of this goal. This has actually contributed to negative growth in tariff for commercial consumers in scenario II in which rationalisation is happening at a faster pace.

Further, the recovery of the existing regulatory assets will bring down the ACoS. As per the latest tariff filing and approvals from the state regulators in Maharashtra, regulatory assets are expected to be recovered fully in the next three to four years. The creation of new regulatory assets is not envisaged post-2020, which is expected to result in lower tariff for consumers.

Summary of results

Based on the assumptions for each components of an electricity bill, CEEW estimates that the electricity costs for commercial customers of MSEDCL will grow at a CAGR (compound annual growth rate) of 3.3 per cent in the case of the partial rationalisation of cross-subsidy and will increase marginally at a CAGR of 0.2 per cent if cross-subsidy is brought down to 120 per cent from the existing 193 per cent. Similarly, for industrial customers, tariff will rise at an expected CAGR of 6.7 per cent and at a lower CAGR of 4 per cent in case the tariffs are set at 120 per cent of ACoS.

For consumers in Mumbai, for all three DISCOMs, electricity tariff for commercial consumers will increase at an average rate of 2 to 3 per cent. For industrial consumers, tariff will rise at an average rate between 3 per cent and 4 per cent. Further, in the case of 105 per cent rationalisation of tariff and assuming that no new regulatory assets will be created, electricity tariff for both C&I consumers will see a dip.

The following general trends emerged from the study:

- The city of Mumbai has enjoyed reliable electricity supply, thanks to islanding and embedded generating stations. However, with growing demand and limited transmission capacity for importing power into Mumbai, reliability of supply could be at risk.
- The resolution of the issue of transmission capacity has been long pending, with right-of-way issues delaying augmentation projects aimed at expanding transmission capacity.

[1] All the estimations in this report are expressed in **nominal terms.** The growth rates assumed in the analysis have been adjusted to cover inflation.

- The consumers of the Mumbai DISCOMs and MSEDCL pay significant amounts for the recovery of regulatory assets. This amount is distributed over four years (up to FY 2019-20) to avoid tariff shocks.
- Consumers in Mumbai pay some of the highest tariffs for different categories (based on CEA (Central Electricity Authority of India) data on retail electricity tariffs) in India. Competition in the distribution business in suburban Mumbai has not succeeded in bringing down tariffs. In fact, the impact has been the exact opposite.
- MSEDCL enjoys a diverse mix of generation sources. It caters to the largest base of consumers in India. The DISCOM is also paying capacity charges for surplus power. MSEDCL needs to explore the option of selling surplus power in the short-term markets to recover power purchase costs.
- The power purchase agreements (PPAs) were signed to meet the growing demand of MSEDCL consumers. The estimations proved to be aggressive, leading to surplus capacity in the state.

Other factors that this study did not consider could also influence electricity prices. These factors are:

- While the government has indicated the goal of reducing cross-subsidy charges, it may prove politically difficult to accomplish this in the foreseeable future.
- Higher penetration of renewables, which are intermittent sources of power, requires a smarter transmission and distribution network to enable balancing of power sources and reliability. These costs are not fully known, but they could substantially aid or hinder the penetration of renewables.
- Environmental commitments arising from the Paris Agreement (2016) would reduce the utilisation of coal plants and when coupled with the potential need to set higher RE targets, an overall increase might be seen for natural gas-based generation. As a result, overall cost of procurement could rise. This could be alternatively considered equivalent to a scenario where a carbon price is in place.
- The rates estimated in this report are exclusive of electricity duty and other taxes levied, as decided from time to time by the government. These charges are payable over and above ABR estimations.

1. Introduction

Maharashtra is the state with the highest electricity generation and consumption in India. It is also an energy-surplus state. The installed capacity in the state, as on May 2017, is 41.7 GW (CEA, 2017). To understand the electricity scenario in Maharashtra, it is convenient to segregate the state into two parts-Mumbai city (including its suburbs) and the rest of Maharashtra. Mumbai city was electrified as early as 1910, powered by the hydel power plants in the Western Ghats (Sethi, 2017). The city has also enjoyed uninterrupted power supply, even when the rest of the state was facing outages, owing to dedicated generation units and efficient maintenance of the transmission and distribution system that supplies to the city. Mumbai city receives its electricity from three DISCOMs-Brihanmumbai Electric Supply & Transport Undertaking (BEST), Reliance Infrastructure Ltd (RIL-D), and Tata Power Company Ltd's Distribution (TPC-D). The Maharashtra State Electricity Distribution Company Ltd (MSEDCL) supplies electricity to the rest of Maharashtra, which makes it the DISCOM catering to the largest consumer base in India (approximately 2.2 crore consumers).[2]

Mumbai city

The distribution companies in Mumbai operate in a densely populated zone, with metered connections and low technical losses. The consumers in the city have high paying capacities compared to other parts of India and they demand reliable supply of electricity throughout the year. All the three distribution companies supplying to Mumbai are privately owned, with TPC-D and RIL-D supplying in the same areas (which are the suburban parts of Mumbai city) and with BEST supplying to the southern part of Mumbai. The consumption mix of Mumbai DISCOMs is given in Table 1.

Table 1 - Consumption mix of Mumbai DISCOMs for FY 2014-15

Category	TPC-D	RIL-D	BEST
LT Residential	5.0%	49.4%	42.4%
LT Non Residential	8.0%	27.9%	36.4%
LT Industrial	4.5%	6.6%	3.3%
HT Industry	35.4%	3.9%	4.1%
HT Commercial	15.9%	7.5%	8.1%
HT Railways	24.4%	-	-
Others	6.9%	4.6%	5.6%

Source: APR filings of respective DISCOMs

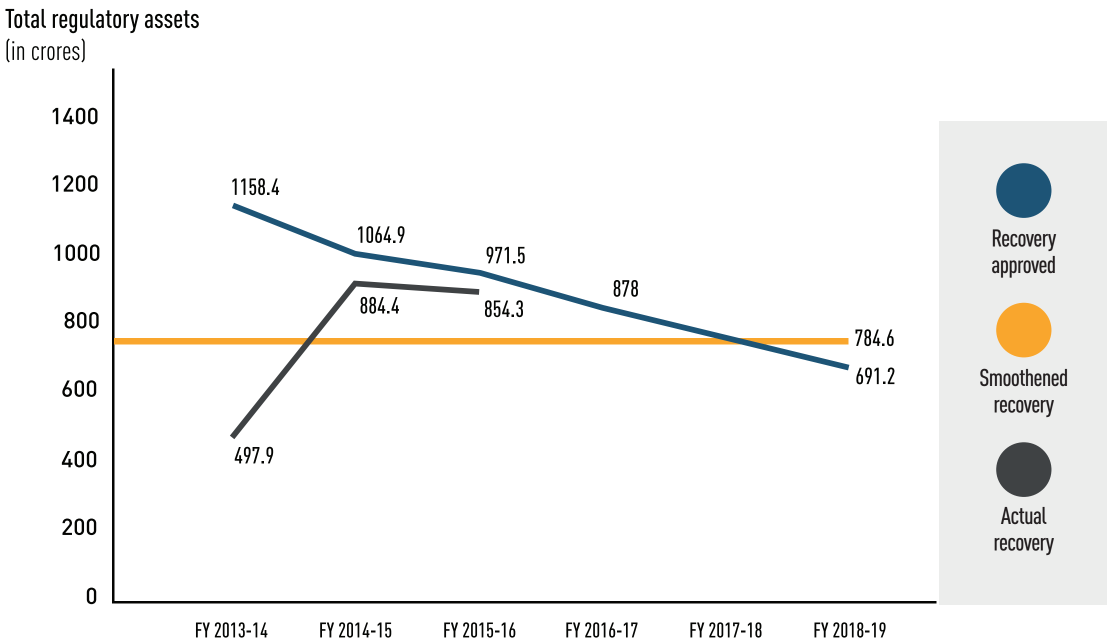
The consumption mix varies across the DISCOMs, with TPC-D supplying to the majority of the subsidising category, that is, commercial and industrial (C&I) consumers, and with RIL-D catering mainly to the subsidised category, that is, domestic consumers. Retail tariffs for the low tension (LT) commercial consumers of BEST are the highest in India (CEA, 2016) for that category. BEST has a fair mix of both the subsidised and subsidising categories. RIL-D and TPC-D, meanwhile, are competing for consumers in the same area. Further, TPC-D has licence to supply electricity in South Mumbai (where BEST is the supplier).

Competition in this area, however, has not yet been operationalised.

[2] The MSEDCL consumer base is: 1,62,61,420 Residential, 36,67,883 Agricultural, 15,69,043 Commercial, 4,38,366 Industrial, and 1,29,661 Other consumers, as per information available on the website of the utility company.

Competition in the distribution of electricity in suburban Mumbai has prompted many consumers to shift to the distribution company with lower tariff, since it was operationalised in July 2008 (Ashwini Chitnis, 2017). This shift in consumption has laid to waste all the estimations in the ARR (annual revenue requirement) filings of RIL-D. The difference in estimated revenues and actual revenues recovered led to the accumulation of losses, thereby resulting in the loss of regulatory assets. The Maharashtra Electricity Regulatory Commission's (MERC) order on RIL-D (ARR and tariff for FY 2016-17 to FY 2019-20 for RIL-D, 2016) states that regulatory charges shall be recovered as a separate charge, and that they shall be recovered from current and changeover consumers (consumers who shifted from RIL-D to TPC-D but are using RIL-D wires) because these involve the recovery of past losses. MERC asked RIL-D to maintain separate accounts for the recovery of regulatory assets. The differences in the approved and recovered regulatory assets of RIL-D are given in Figure 1.

Figure 1 - Regulatory asset recovery of RIL-D



Source: MYT of RIL-D for FY 2013 and FY 2016

The revenue gap, including the regulatory assets, for TPC-D stood at INR 1,232 crore up to FY 2015-16 (ARR and Tariff for FY 2016-17 to FY 2019-20 for TPC-D, 2016). In contrast to the process followed for the recovery of RIL-D's regulatory assets, TPC-D's assets were meant to be recovered in the conventional manner, by adding them to its [the company's] revenue requirement.

It is ironic that changeover consumers had to pay for the recovery of regulatory assets of both DISCOMs. They paid for TPC-D's charges (which included regulatory asset charges) and also paid for RIL-D's regulatory asset charges. This was a result of contentious orders from MERC, which aimed to bring the tariffs down by introducing competition in distribution supply in suburban Mumbai.

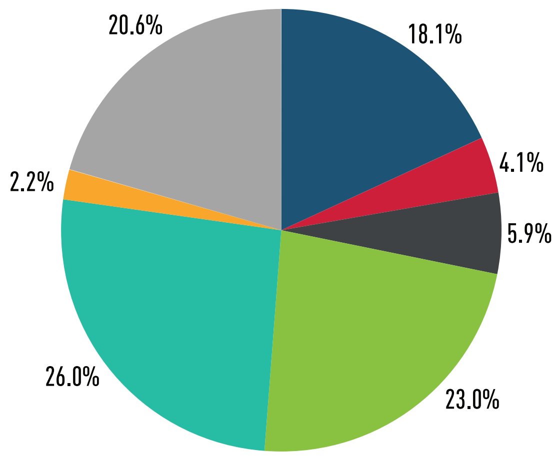
Competition in retail supply has made load forecasting a challenge, adding to the existing complexities in assumptions made for estimating retail supply tariffs. Further, some additional charges, like regulatory asset charges and cross-subsidy surcharge, discussed in detail in the following sections, also contribute to the complexity. Apart from these additional charges, transmission constraints in Mumbai have been a hindrance to the signing of PPAs through competitive bidding. In short, Mumbai presents a complex case for the estimation of retail tariffs.

Rest of Maharashtra

MSEDCL caters to the rest of Maharashtra, except for a few areas, which have been handed to distribution franchisees. The Bhiwandi area is operated and maintained by Torrent Power Ltd. A few urban areas (the technical term in the distribution sector is circle) of Nagpur are operated by SND Ltd. The consumption mix (by sales, in million unit [MU]) of MSEDCL is shown in Figure 2.

Figure 2 - MSEDCL consumption mix, FY 2014-15

Category	FY 2014-15
LT Residential	18.1%
LT Non-residential	4.1%
LT Industrial	5.9%
LT Agricultural	23.0%
HT Industry	26.0%
HT Commercial	2.2%
Others	20.6%



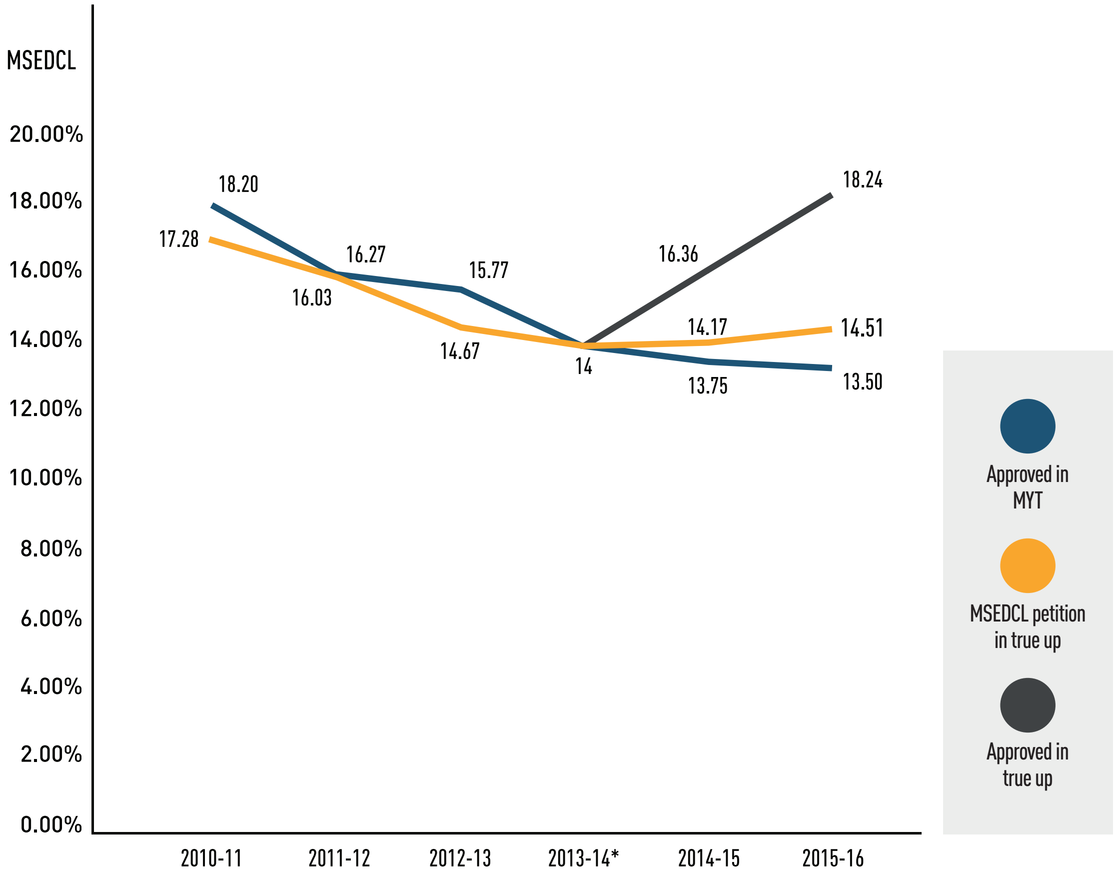
Source: APR of MSEDCL

The consumption mix indicates the diverse energy mix to which MSEDCL caters. The subsidised category of agricultural and residential consumers accounts for 41 per cent of the consumption mix, and the subsidising category of C&I consumers accounts for 38 per cent of the consumption. MSEDCL ensures uninterrupted supply to its consumers; 85 per cent of the state is free of load shedding and 15 per cent is under load shedding.[3]

The distribution loss trajectory for MSEDCL is given in Figure 3. Distribution losses approved by MERC have increased after FY 2013-14. This is because of the increase in sales at the LT level and wide-spread distribution of farmlands, which have contributed to increasing losses. MERC, in its latest MYT order for MSEDCL (ARR for MSEDCL for 3rd Control Period FY 2016-17 to FY 2019-20, 2016), approved the loss level after ascertaining the scale of agricultural sales. MERC has pointed out that MSEDCL has inflated the sales for the agricultural category and has approved the distribution losses after ascertaining the actual agricultural sales. Agricultural sales and metering has been a contentious issue, with several consumer representatives raising objections to the data submitted by MSEDCL.

[3] As per information on the MSEDCL website, the DISCOM can ensure uninterrupted supply to the remaining 15 per cent of the area, but these areas have high commercial losses. MSEDCL purposely implements load shedding in these areas to bring about consumer discipline.

Figure 3 - Distribution losses of MSEDCL



Source: APRs and true-up of MSEDCL for respective years

Further, several objections were raised about escalating power purchase costs, especially from the state generator, Maharashtra State Power Generation Company Ltd (MSPGCL). The issues of power purchase costs and the payment of capacity charges for 'idle generating units' are discussed in the following sections.

In this context, this report attempts to estimate (a future-oriented) electricity tariff trajectory for consumers in Mumbai and in the rest of Maharashtra. It details the methodology of the study, the assumptions on which the estimates are based, and the limitations of these estimates. The estimates also incorporate two scenarios of RE growth and the impact on the cost of procurement.

For the purpose of estimation and analysis, this report has sourced the majority of the data from the previous ARR orders of the Maharashtra Electricity Regulatory Commission (MERC). The data for estimations of transmission and power procurement costs are sourced from the reports of Maharashtra State Electricity Transmission Company Ltd (MSETCL) and the Central Electricity Authority of India (CEA).

It is important to note that there is a fair amount of uncertainty associated with the estimates, owing to the fact that power procurement cost, transmission charges and administrative expenses can vary significantly given their dependence on multiple factors, which are susceptive to real market conditions. All these elements add to the complexity of tariff estimation.

2. Cost of Supply Model

This report attempts to estimate retail tariffs for consumers of four DISCOMs in the state of Maharashtra. In our estimations, we have followed the cost of supply model to arrive at different tariff rates for consumers. The cost of supply model has various key components that are involved in the computation of the retail tariff. These components include power purchase costs, inter-state and intra-state transmission charges, operating expenses of DISCOMs, regulatory asset charges, etc. Of these components, power purchase costs constitute nearly 69 per cent of the annual expenses of DISCOMs, which forms the basis for further discussions on the cost of power from different energy mixes, in the following sections.

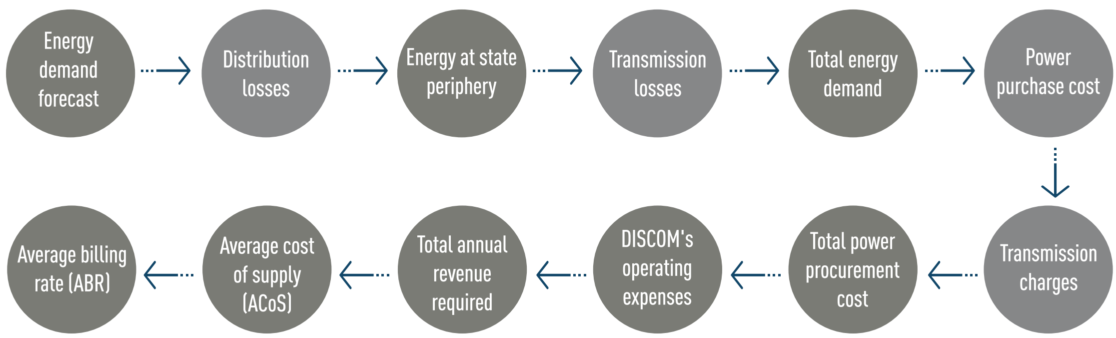
2.1 ARR of DISCOMs: An overview

Mumbai DISCOMs are some of the better performing ones in India, despite their recent accumulation of regulatory assets. They cater to an urban consumer base with high paying capacities, all of which is metered, and has a fair mix of subsidised and subsidising consumers. MSEDCL is one of the better performing state DISCOMs, ranking seventh among forty-one (Power Finance Corporation, 2017). The technical and commercial losses are relatively low for all four DISCOMs. MSEDCL caters to a sizeable urban-rural consumer mix, which accounts for significant industrial consumption. Supplying electricity through extensive distribution networks requires a comprehensive structure to determine both ARR and the retail supply tariffs. DISCOMs use the cost of supply model to determine tariff rates in order to recover the incurred expenses from consumers.

The expenses that are incurred by DISCOMs are either for O&M, administrative purposes, or for power procurement from generators. Power procurement cost also incorporates inter-state and intra-state transmission line losses, distribution losses, and transmission charges. DISCOMs are required to estimate their aggregate revenue requirement based on the expenses they will incur in the following financial year, which is then reviewed by MERC. The regulatory process involved in estimating ARR for DISCOMs is shown in Figure 3.

The methodology followed in this study estimates the future trajectory of the key components out of all the ARR components (Figure 4), while assuming that the rest are following the historical trend observed so far. The detailed estimation process and the assumptions are discussed in the following sections.

Figure 4 - Regulatory process of estimating ARR and retail supply tariffs



Source: CEEW compilation of APR documents

2.2 Observations on the cost of supply

An assessment of data from the filings of the Maharashtra DISCOMs shows the key components of the cost of supply (Figure 5). It is observed that the cost of power purchase forms the major portion of the ARR. The transmission costs for Mumbai DISCOMs are about 4-5 per cent of the total costs. The share of transmission costs for MSEDCL are about 10 per cent of the total costs.[4] The transmission lines used to supply electricity into Mumbai city are limited. This is because of the delay in the commissioning of transmission projects. Due to limited transmission assets, utilisation of transmission equipment in Mumbai is high, and hence the costs are lower on a per unit basis compared to the rest of Maharashtra. Further, Mumbai consumers pay standby charges and regulatory asset charges, which dilute or reduce the share of transmission costs in total costs when compared to MSEDCL.

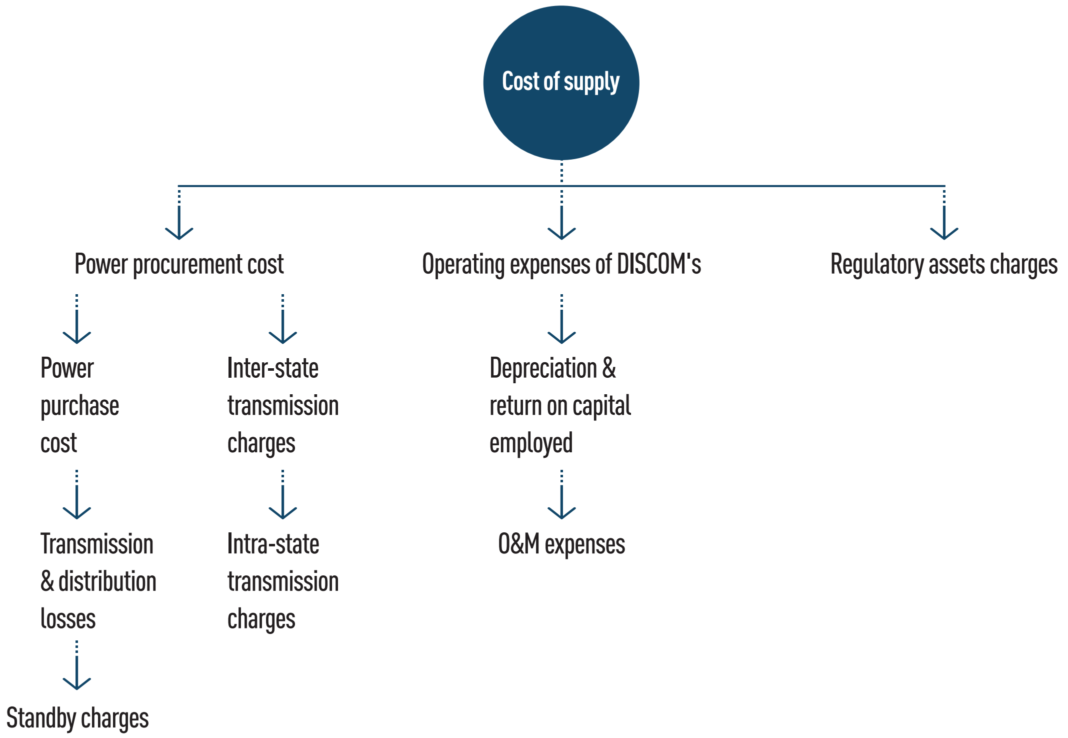
Distribution-related costs comprise expenses towards loan repayment, depreciation, operations and maintenance, employee remunerations, pensions, etc. (Figure 5). These distribution-related cost trends indicate that their share has remained relatively unchanged in the overall cost of supply for MSEDCL. However, for the three Mumbai DISCOMs, distribution-related costs vary from 15 per cent to 27 per cent. Additionally, regulatory asset charges are levied on consumers of RIL-D and TPC-D, which constitute 11-24 per cent of total charges. Also, based on the observation of a flat trend in transmission costs and budgetary outlays for the transmission sector (both at the state and central levels), an estimation of transmission costs has been undertaken in the analysis.

Thus, the approach for determining the overall cost of supply is driven primarily by the power purchase quantum, the energy generation mix, and the cost of supply from each source. Apart from above-mentioned components, consumers in Mumbai were levied standby charges for the provision of uninterrupted supply. Standby charges are levied by MSEDCL on all three Mumbai DISCOMs to ensure supply from its lines via the interconnection points of TPC and RIL. The embedded generating stations of TPC and RIL, at Trombay and Dahanu respectively, are connected to the MSETCL lines. In the case of outages, these stations and their interconnection lines will be used to supply electricity from the standby stations of MSEDCL.[5] MERC, in its 2008 order on standby support from MSEDCL (MSEDCL's Petition seeking approval of the agreement for Standby Support by, 2009), directed MSEDCL to prepare separate agreements with all three DISCOMs without imposing any financial burden on them. Therefore, standby charges will be based on the quantum of energy consumed by the DISCOMs and will not see any escalation on a per unit basis for the coming decade.

The transmission costs for Mumbai DISCOMs are about 4–5 per cent of the total costs

[4] The shares of the transmission costs of Mumbai DISCOMs and MSEDCL are taken from the projections of the respective DISCOMs in their ARRs for FY 2016–17.

Figure 5 - Components of cost of supply for Mumbai DISCOMs and MSEDCL*



Source: CEEW analysis

** Consumers of MSEDCL are not levied standby charges; these are applicable on consumers of Mumbai DISCOMs to ensure uninterrupted supply*

The share of cost of supply components for all four DISCOMs, based on estimations of DISCOMs for FY 2016-17, is given in Table 2.

Table 2 - Share of cost of supply components

Components of Cost of Supply	BEST	RIL-D	TPC-D	MSEDCL
Power purchase cost	47%	56%	53%	69%
Transmission charges	5%	4%	5%	10%
Standby charges	2%	2%	3%	-
Regulatory asset charges	24%	11%	24%	1%
Operating expenses of DISCOMs	22%	27%	15%	20%

Source: CEEW compilation, from ARR documents of respective DISCOMs

[5] MSEDCL is not a power-generating entity, but it procures additional power from various sources and levies the charges for standby power on Mumbai DISCOMs on a monthly basis.

3. Estimations of Cost of Supply

As mentioned in the previous section, the key components in the estimation of the cost of supply for DISCOMs are: (1) power procurement cost, which, in turn, is a factor of the energy demand and the purchase costs associated with each source and the associated transmission and distribution losses; (2) transmission and distribution charges; and DISCOM expenses, which factors in ROE and O&M expenses such as salaries of employees, regular maintenance of assets, etc.

The energy demand estimations for Mumbai and MSEDCL are shown in Table 3. The estimations are based on ten-year growth rates of all consumer categories. The ten-year CAGRs of total sales estimations (Table 3), looking ahead, for RIL-D and TPC-D are inclusive of the sales of changeover consumers.

High Tension (HT) sales of DISCOMs for FY 2015-16 indicate the high share of subsidising consumers of TPC-D as compared to other DISCOMs. The growth rate of C&I consumers of TPC-D, however, shows a negative growth, which could be because of consumers moving back to RIL-D.

Table 3 - Current and upcoming trends in sales of DISCOMs

Particulars (all in %)	BEST	RIL-D	TPC-D	MSEDCL
Share of HT sales in total sales for FY 2015–16	16%	12%	82%	35%
Ten-year CAGR of total sales estimations from FY 2015–16 to FY 2025–26	2.4%	5.5%	3.2%	6.3%
Ten-year CAGR of HT industrial sales estimations from FY 2015–16 to FY 2025–26	-5.4%	3.3%	-2.8%	2.1%
Ten-year CAGR of HT commercial sales estimations from FY 2015–16 to FY 2025–26	-2.2%	3.8%	0.5%	6.3%

Source: Based on APRs of respective DISCOMs, CEEW estimations

One of the major challenges in estimating the cost of supply for Mumbai DISCOMs is the limited transmission capacity to import power into the city. This is discussed in detail in section 3.2. For MSEDCL, many HT consumers are opting for open access. Indian Railways, for instance, has opted for open access (for traction purposes). As a result, its demand from MSEDCL has fallen by 95 per cent (from 1437 MUs in 2014-15 to 77 MUs in 2016-17).[6] Further, 10-year growth in the HT industrial category has been low at 2.1 per cent, indicating a slump in the sales of the HT category.

Since this study uses the energy balance system and attempts to estimate the costs from demand, T&D losses are integral to the calculation of the power procurement costs. The above-mentioned parameters affect the power procurement costs, but in order to compute the total cost of supply, the transmission charges (of the utilities involved) also need to be considered.

[6] The Indian Railways was granted a deemed distribution licence in November 2015 by CERC. This has opened up the option of signing long-term agreements based on open access..

Transmission charges include intra-state transmission charges, inter-state transmission charges, and SLDC (State Load Despatch Centre) charges (which are not very significant).

These parameters are used to estimate the total cost of supply (Table 10). Some factors like fuel prices, the energy mix of generation plants, and generation tariffs tend to affect the cost of supply more significantly than others.

3.1 Power procurement cost to DISCOMs

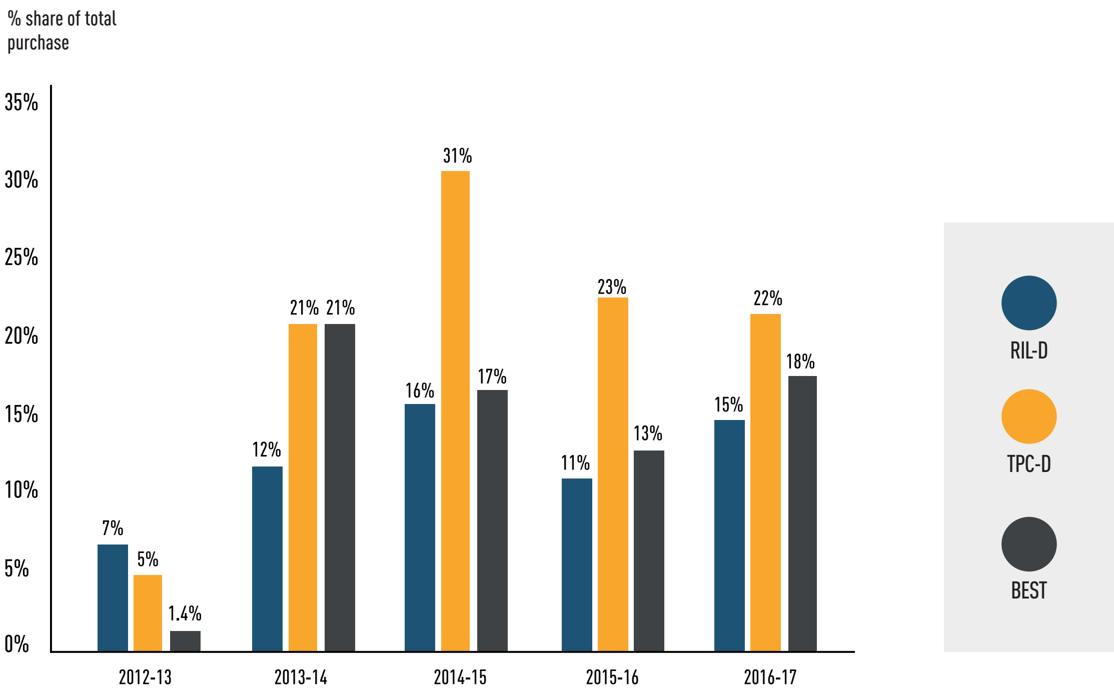
Power procurement cost accounts for the largest share in the total ARR for DISCOMs. Power procurement cost includes power purchase costs, transmission and distribution losses, and standby charges (in the case of the Mumbai DISCOMs). Estimation of power procurement cost is based on the quantum of power sourced from different generating stations. In order to budget the power procurement costs based on the quantum of power to be procured, it is necessary for DISCOMs to determine the current energy demand and to project the future energy demand. Energy demand values also help DISCOMs plan their energy mix along with estimating the procurement costs associated with it.

One-fourth of Mumbai's electricity supply comes from open markets

Mumbai city

Suburban Mumbai's electricity imports have increased significantly in the last decade. In FY 2007-08, 93 per cent of the electricity was procured from the Trombay and Dahanu generating stations (Ashwini Chitnis, 2017). This amount was reduced to 47 per cent in FY 2015-16, mainly due to an increasing mismatch in demand and embedded generation.[7] One-fourth of Mumbai's electricity supply comes from open markets. Figure 6 shows the short-term purchases of the Mumbai DISCOMs.

Figure 6 - Share of short-term purchases of Mumbai DISCOMs



Source: CEEW assumptions for estimation of transmission charges

[7] Embedded generation refers to power generation from stations within the Mumbai city limits. Currently, the stations in operation are Trombay and Dahanu and the hydro power plant in Khopoli.

The Mumbai DISCOMs procure the majority of their power from coal-based generating stations. Apart from coal, the hydro stations located in the outskirts of Mumbai contribute to the demand of the DISCOMs. The generation capacity mix of the three Mumbai DISCOMs for FY 2016-17 is shown in Table 4.

Table 4 - Source-wise generation mix of Mumbai DISCOMs and MSEDCL

Power procurement through short-term purchases

Source of Fuel	BEST	RIL-D	TPC-D	MSEDCL #
Coal	58.7%	82.1%	56.9%	81.5%
Hydro	14.5%	0.0%	12.2%	3.9%
Solar	0.6%	0.7%	0.9%	7.1%*
Non-Solar	2.8%	2.2%	7.3%	
Nuclear	-	-	-	3.8%
Bilateral	15.6%	15.6%	22.7%	1.1%

Source: APRs for FY 2016-17 of respective DISCOMs

** For MSEDCL, solar and non-solar are classified as renewables*

 # Other than the sources listed, natural gas contributes 2.8 percent to the total energy mix

The PPAs of TPC-D and BEST with the Trombay generating station are due to run out by 31 March 2018. BEST has floated tenders to procure power under medium-term PPAs. The PPA with TPC-G has been extended up to the end of March 2019 (MERC, 2018). RIL-D's petition for the renewal of its PPA with the Dahanu power plant was approved by MERC. This PPA has been extended to 2022 (MERC, 2018). RIL-D has projected (in its latest MYT order up to FY 2019-20) a 2 per cent year-on-year increase in power purchase costs from the base rate of INR 4.27/kWh for FY 2016-17 for procuring power from the Dahanu power station. There is strong opposition to the renewal of PPAs with the Dahanu power station from consumer representatives and civil society groups (Submission of PEG on Case No.05 of 2017/01525 of MERC, 2017), who are calling for the competitive bidding route to drive down power purchase costs.

The DISCOMs of Mumbai have cited transmission constraints as a reason for procuring power from the existing generation stations, especially unit 6 of the Trombay plant (ARR and Tariff for FY 2016-17 to FY 2019-20 for RIL-D, 2016), which is an oil-based unit, generating at about INR 17/kWh. MERC directed MSETCL to present realistic transmission scenarios, looking ahead, and to bring clarity regarding the power procurement options for Mumbai DISCOMs. This uncertainty is unlikely to be resolved till such time as there is clarity on the available transmission capacity.

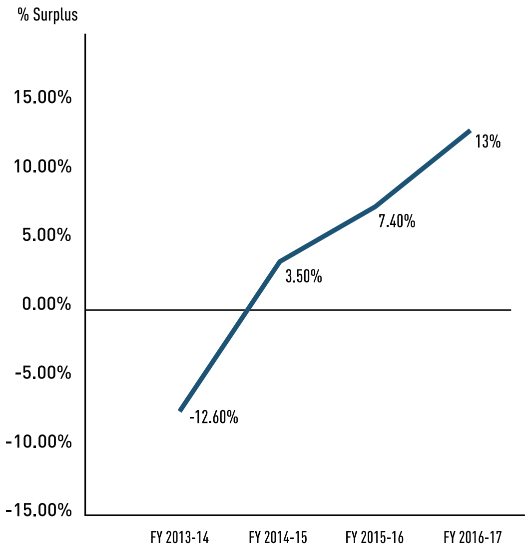
This has presented a challenge in estimating the power procurement costs, looking ahead, as it is based on whether or not MERC will approve the renewal of the existing PPAs, or whether it will attempt the route of competitive bidding, which could bring about changes in the power procurement costs. In this context, the assumptions for calculating power procurement costs were made on the basis of two different scenarios for power procurement costs, which are discussed in detail in section 3.1.2.

MSEDCL: Power surplus?

Maharashtra has the highest installed coal generation capacity and the second highest installed renewable generation capacity (after Tamil Nadu) in India (CEA, 2017). The state also has gas, nuclear, and hydro power generating stations, all of which supply power to MSEDCL. Maharashtra has been enjoying a power-surplus situation for the last three years (Figure 7). This surplus situation can be attributed to the surplus situation in MSEDCL because the three Mumbai DISCOMs have limited options to import power into the city.

Surplus situation can be attributed to the surplus situation in MSEDCL because the three Mumbai DISCOMs have limited options to import power into the city

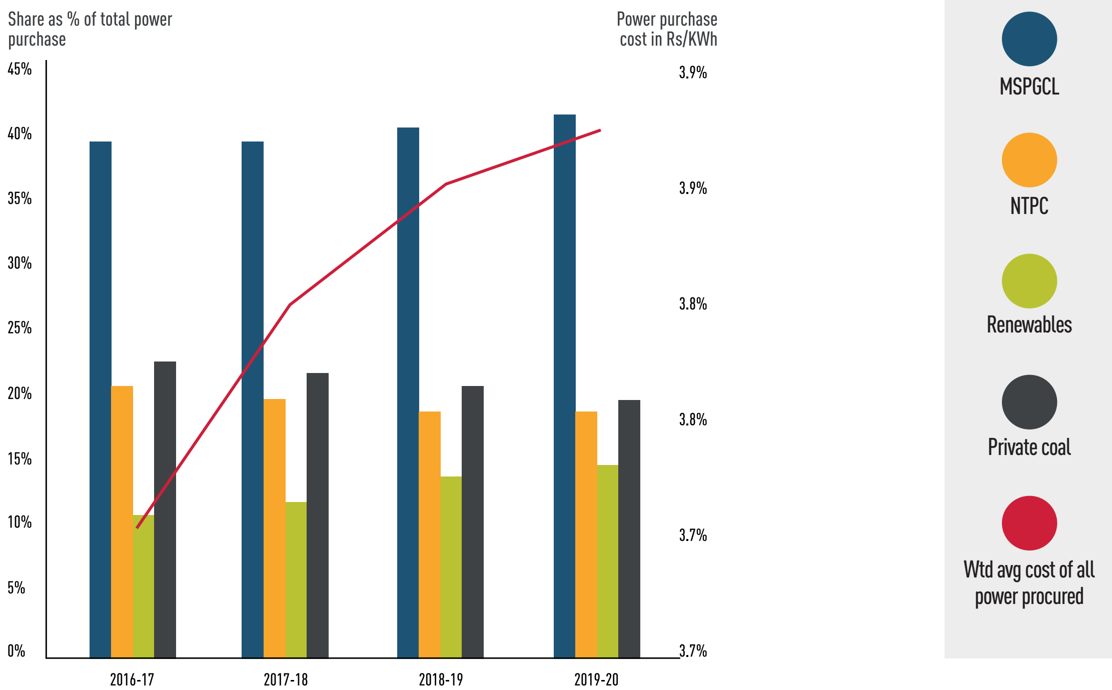
Figure 7 - Surplus-power position in Maharashtra



Source: Load Generation Balance Reports, CEA, for respective years

MSEDCL procures the majority of its power from the state generator, MSPGCL. In its latest MYT order (ARR for MSEDCL for 3rd Control Period FY 2016-17 to FY 2019-20, 2016), MERC has approved the decision to increase the share of power to be procured from MSPGCL and renewables. The share of procurement from the National Thermal Power Corporation Ltd (NTPC) and from private coal plants has been shrinking in the same period. The share of power procured and the average cost of power purchase for FY 2016-17 to FY 2019-20 respectively are shown in Figure 8.

Figure 8 - Trends in MSEDCL power purchases



Source: MYT of MSEDCL from FY 2016-17 to FY 2019-20

Several consumer representatives have pointed to the fact that MSEDCL is stuck with PPAs for excess capacity and is facing the burden of paying for capacity charges under these PPAs, which is a burden on the consumer (ARR for MSEDCL for 3rd Control Period FY 2016-17 to FY 2019-20, 2016). Suggestions from consumer representatives included the economic shutdown of costly units and of units running on low plant load factors (PLFs). MSPGCL, in 2014, proposed shutting down five old and under-performing units to optimise resources for other generating units (Economic shutdown of units to optimize resources and achieve economy in coal-based operations, 2014). MSEDCL, in its latest MYT, has proposed shutting down the costlier units to avoid paying their capacity charges. MERC has approved the least costly merit order of despatch for the procurement of power.

In this context, it is unlikely that the additional coal capacity is benefitting MSEDCL or Maharashtra state. MSEDCL as a seller has to look to short-term markets to recover its power procurement costs. Despite growing demand, the generation mix of coal power is assumed to decline, while the share of renewables is assumed to increase.

3.1.1 Estimating Energy Sales

The first step in estimating power procurement costs is to estimate the electricity demand of the DISCOM. DISCOMs have multiple energy users and assessing the total energy demand in the future becomes more accurate when the projections of the energy demand of each individual consumer category is based on that category's current and historical growth trends. The challenges of estimating demand are discussed in the Introduction. The energy sales estimation for all four DISCOMs is discussed below.

Mumbai city

Estimating energy sales for suburban Mumbai (which is supplied by RIL-D and TPC-D) is a challenge because of uncertainty in the estimation of changeover consumers. Based on historical trends, the average of the growth rate observed in an 11-year period was taken as a basis for sales estimations for TPC-D and BEST. For RIL-D, the average of the growth rate over a 10-year period was taken as a basis for sales estimations.

TPC-D has a distribution license to supply electricity in both South and suburban Mumbai. The parallel licensees have not yet been operationalised in South Mumbai. The estimations, therefore, are limited as per the existing licensee operations and have not taken into account the change in the status of the distribution licensees.

A wide range of factors could affect electricity demand and consumer share in a region. While estimating the energy sales for each consumer category, it is important to note the historical trends. The DISCOMs use time-series trends for multiple years (up to 10 years) to estimate future energy sales. Building on this approach, this study estimates energy sales based on the growth trends of the pertinent categories. Unlike the CEEW analysis for Delhi (Council on Energy, Environment and Water, 2017), the estimations in this report have taken an average growth rate to normalise spikes in the growth rate, observed because of the competition between the licensees in the Mumbai distribution sector. Some assumptions have been made in projecting the future sales of these categories, which are given in Table 5.

Table 5 - Energy sales estimations for different categories of consumers for RIL-D (in MU)

Power procurement through short-term purchases

Particulars*	FY 2010-11	FY 2016-17	Avg. sales from FY 2010–11 to FY 2016–17	% share of Avg. consumer category sales	FY 2019–20	FY 2024–25
Domestic	4,436	6,722	3,963	53%	4,312	4,812
Non-Domestic	2,205	4,776	2,330	31%	3,266	4,264
Industrial	605	847	709	9%	901	1,184
Total	7,448	10,280	7,497		11,058	13,144

Source: CEEW estimations, from APR documents of respective DISCOMs

** All figures are total of HT and LT sales for the respective category*

Table 5 shows the energy sales estimations for different years and the share of each consumer category for RIL-D. This is not an exhaustive list of consumer categories, but is a list of the key categories in determining the overall tariffs. Domestic category sales are growing at a consistent but low rate. The growth rate of the commercial (non-domestic) category, on the other hand, is relatively high. Hence, the share of commercial sales in total sales is growing. Similar estimations for TPC-D and BEST are shown in Annexure I.

MSEDCL

In its MYT order, MSEDCL has estimated the energy consumption of the different consumer categories based on the category-wise growth trend for the past years. Building on this approach, the sales estimations were based on the 10-year growth rate for the respective categories. Wherever the growth rate seemed unrealistic or where it did not conform to the more recent trends, a conservative growth rate was used. Energy sales estimations for the different categories of consumers are given in Table 6.

Table 6 - Energy sales estimations for different categories of consumers for (in MU)

Particulars*	FY 2007-08	FY 2016-17	Avg. sales from FY 2007–08 to FY 2016–17	% share of Avg. consumer category sales	FY 2019–20	FY 2024–25
Domestic	9,226	19,403	14,654	18%	24,423	35,838
Non-Domestic	2,503	6,568	5,067	6%	7,834	10,645
Industrial	26,827	30,343	28,959	36%	34,883	39,245
Agriculture	12,323	30,250	22,537	28%	37,076	52,441
Total	55,727	96,789	79,875		117,288	157,578

Source: CEEW estimations, from APR documents of respective DISCOMs

** All figures are total of HT and LT sales for the respective category*

This is not an exhaustive list of consumer categories. The share of these categories, however, is a percentage of the total average sales. Domestic category sales are growing at a consistent rate at a CAGR of 8 per cent. The growth rate of the industrial and commercial (non-domestic) category, on the other hand, is relatively lower.

3.1.2 Power purchase cost

Power purchase cost (which is a sub-set of power procurement cost) refers to the rate at which the DISCOM purchases power from various generation stations. These costs are based on the purchase contracts signed by the DISCOMs with power generators. There are two types of power projects with whom DISCOMs sign PPAs, namely cost plus-based projects and competitively bid power projects. The tariff for cost plus-based projects is determined by the regulator and everything is a pass-through, creating variability risk to the tariff. In contrast, the tariffs for competitively bid power projects have a more fixed nature. It is useful to analyse the share of these categories.

Power purchase cost is calculated on the basis of fixed and variable costs of each generating plant and the total quantum of electricity sourced from the respective plants. The Mumbai DISCOMs procure from a limited number of plants-Trombay station, Dahanu station, Vidarbha Industries Power Ltd, and Khopoli hydroelectric station-and the rest is sourced from open access.

MSEDCL sources its power from MSPGCL and from the two central generation companies, National Thermal Power Corporation Ltd (NTPC) and Nuclear Power Corporation of India (NPCIL). Apart from these, independent power plants in the state and RE plants supply to the DISCOM. It becomes cumbersome to track changes in the annual price rise for each of the plants and also to estimate the cost of generation from upcoming plants. To overcome this problem, DISCOMs either use the generation tariff approved by the Central Electricity Regulatory Commission (CERC) in the MYT orders or assume a certain hike in the tariff based on historical trends for all generating plants. However, the actual generation tariff could be different from the one assumed for ARR, which is then adjusted in true-up petitions.

Based on the fixed and variable cost components of the power plants supplying power to DISCOMs, it is observed that the variable component of the generation tariff is the key driver of future costs of procurement and is based on fuel prices and the actual operating performance of power plants.

Determination of Generation Tariff for Power Plants

Generation tariff for power plants consists of fixed and variable components, which represent capital expenditure and fuel expenditure respectively.

Fixed cost component (capital expenditure) includes depreciation, interest on loan, return on equity, interest on working capital, operations and maintenance expenses, and special allowances.

Variable cost component (fuel expenditure) is dependent on the consumption of primary and secondary fuel. Consumption of primary and secondary fuel depends on the operating parameters, heat rate, plant load factor, auxiliary consumption, plant availability factor, calorific value of fuel, etc. of a particular plant.

Apart from their long-term PPAs with various generating stations, the Mumbai DISCOMs procure a significant share of their in the short-term market (Figure 10). In their ARR filings, the Mumbai DISCOMs have cited transmission constraints as a hindrance to signing long-term PPAs with generating stations from outside the city. This has led to an increase in the share of short-term purchases. MSEDCL, on the other hand, has significant surplus capacity, and is struggling to sell this surplus supply at reasonable rates in the short-term market, so as to recover its power purchase costs. The rates in the short-term markets are lower than the power purchase costs of MSEDCL, which has created revenue gaps because of surplus availability.

Further, MSEDCL has not been able to estimate the demand for some categories (especially agricultural consumption) accurately. This leads to over-estimation of the quantity of power to be purchased, thereby increasing the power purchase costs and widening the revenue gaps.

Mumbai city

For estimating the generation tariff, two scenarios are considered, which capture variation in the energy mix of the Mumbai DISCOMs. The current generation mix of DISCOMs is given in Table 4. Table 4 shows the change in the generation mix in the two scenarios, going forward.

Table 7 - Generation mix of Mumbai DISCOMs for FY 2019-20

FY 2019–20	Scenario 1			Scenario 2		
Source of Fuel	BEST	RIL-D	TPC-D	BEST	RIL-D	TPC-D
Coal	56%	76.5%	51.9%	60.2%	77.3%	57.2%
Hydro	13.5%	0.0%	11.4%	11.7%	0.0%	12.6%
Solar	0.6%	2.4%	2.8%	5.0%	5.0%	5.0%
Non-solar	5.3%	2.0%	9.2%	10.0%	10.0%	10.0%
Bilateral	24.6%	19.1%	24.6%	13.1%	7.7%	15.2%

Source: CEEW estimations

Table 8 - Generation mix of Mumbai DISCOMs for FY 2024-25

FY 2024–25	Scenario 1			Scenario 2		
Source of Fuel	BEST	RIL-D	TPC-D	BEST	RIL-D	TPC-D
Coal	56%	76.5%	51.9%	60.7%	64.0%	51.9%
Hydro	13.5%	0.0%	11.4%	11.8%	0.0%	11.4%
Solar	0.6%	2.4%	2.8%	9.2%	9.2%	9.2%
Non-solar	5.3%	2.0%	9.2%	14.8%	14.8%	14.8%
Bilateral	24.6%	19.1%	24.6%	3.5%	12.0%	12.7%

Source: CEEW estimations

The scenarios mentioned above take the varying generation mixes into account. The three Mumbai DISCOMs purchase a considerable share of their procurement from short-term markets (bilateral purchases). The high-RE scenario (scenario II) has assumed reduction in the bilateral share, which has been apportioned to RE (solar and non-solar) and coal. Therefore, there is an increase in the coal share in the high-RE scenario. This is evident in the case of BEST and RIL-D for FY 2019-20. To estimate power procurement costs, assumptions were made about fuel price escalations. The fuel price escalations and their impact on variable charges are discussed below.

Table 9 - Fuel price escalations for Mumbai DISCOMs

FY 2024–25	Scenario 1			Scenario 2		
Source of Fuel	BEST	RIL-D	TPC-D	BEST	RIL-D	TPC-D
Coal	56%	76.5%	51.9%	60.7%	64.0%	51.9%
Hydro	13.5%	0.0%	11.4%	11.8%	0.0%	11.4%
Solar	0.6%	2.4%	2.8%	9.2%	9.2%	9.2%
Non-solar	5.3%	2.0%	9.2%	14.8%	14.8%	14.8%
Bilateral	24.6%	19.1%	24.6%	3.5%	12.0%	12.7%

Source: CEEW estimations

The generation mix and the power procurement costs in both the scenarios are discussed in detail in Annexure II.

MSEDCL

For estimating the generation tariff, three scenarios are considered that capture the variation in the energy mix of MSEDCL. The base case scenario assumes the same energy mix as the current energy mix of MSEDCL (Table 4). The scenarios (other than the base case scenario) are shown in Figure 9:

Figure 9 - Generation mix assumed for estimation of power purchase costs

Scenario I - Low renewables	Scenario I - High renewables
Renewables contribute to 11% of the total supply by 2020 and to 15% by 2025.	Renewables contribute to 15% of the total supply by 2020 and to 20% by 2025.
Share of hydro and gas is assumed to remain unchanged at 3.9% and 2.8% respectively.	Share of coal capacity is decreasing in proportion to the increasing capacity of renewables.
Share of nuclear is assumed to remain unchanged at 3.8%.	Share of hydro, nuclear and gas is assumed to remain unchanged at 3.9%, 3.8% and 2.8% respectively.
Open access purchase currently at 2.3% is assumed to dcrease at nil.	
Share of coal-based power is assumed to decrease with increasing share of renewables.	

Source: CEEW estimations

The fuel price escalations and their impact on variable charges for thermal generation are discussed below.

- The orders indicate a 9.1 per cent hike in variable charges for coal, based on data of domestic coal prices from power plants operating in India over six years.
- Hike in variable costs for gas power plants is assumed at 6.2 per cent (Amol Phadke, December 2016). This is the 10-year CAGR for LNG (liquefied natural gas) prices.
- The generation tariff escalation assumed for hydro stations is 1.3 per cent, based on tariff approved by CERC for 2015-16 to 2018-19.
- Solar tariffs are considered as per market trends. Current market trends show a steep decline in the prices of upcoming plants, and hence a decline of 5 per cent is assumed.
- Hike in the costs for nuclear power plants was found to be minimal. Hence, no escalation in the cost of procurement is assumed. Tariff escalation for other sources is assumed on the basis of historical trends.

3.1.3 Estimation of transmission and distribution losses

Transmission and distribution losses are used to estimate the power procurement cost, over and above the power purchase cost, since the additional cost due to transmission and distribution losses is borne by the DISCOMs and needs to be computed along with the retail supply tariff for consumers. Unlike CEEW's analysis of electricity tariffs for Delhi (Council on Energy, Environment and Water, 2017), this analysis does not segregate inter-state and intra-state transmission losses.

The delay in transmission projects is because of right-of-way issues; there is load growth in nearby districts; and the islanding scheme in Mumbai is redundant

Mumbai city

The transmission losses incurred for supplying power to the Mumbai DISCOMs are assumed to be decreasing at a rate of 0.01 per cent year-on-year. MERC has considered the same decline in transmission losses in its orders. The transmission losses of the three Mumbai DISCOMs are given in Table 10.

Table 10 - Transmission loss trajectory for Mumbai DISCOMs

DISCOM	2016-17	2019-20	2024-25
BEST	3.92%	3.92%	3.87%
RIL-D	3.92%	3.92%	3.87%
TPC-D	3.89%	3.89%	3.84%

Source: MYT of respective DISCOMs, FY 2016-17 to FY 2019-20

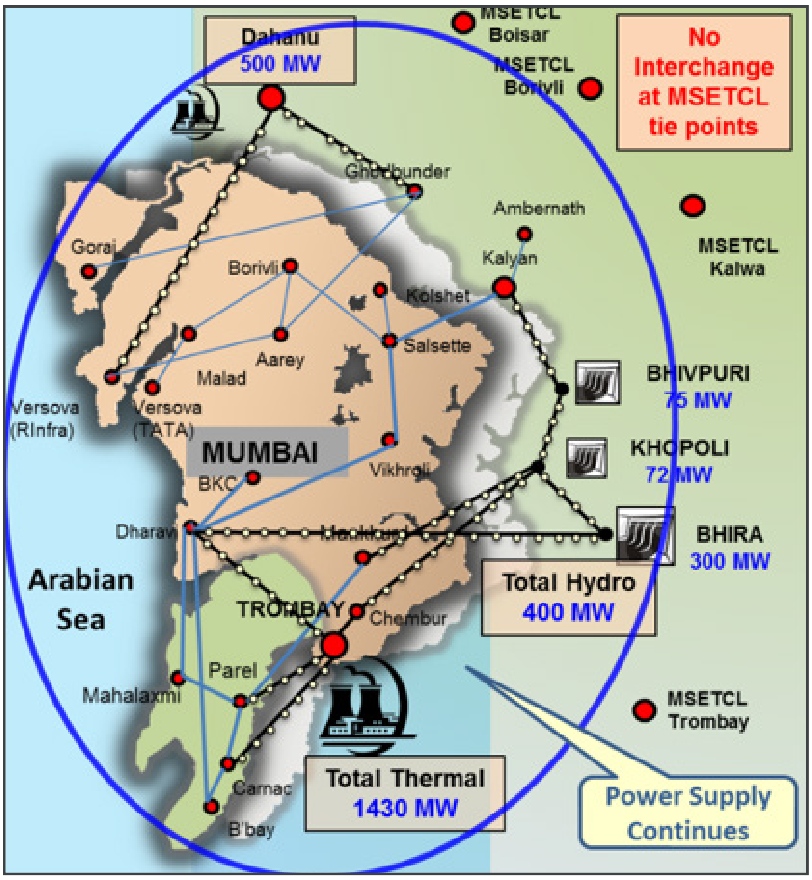
MERC in the MYT orders for the respective DISCOMs has considered no decrease in transmission losses in the control period for all three DISCOMs. However, we have assumed improvements in system efficiency, leading to a decrease in transmission losses.

Apart from transmission losses, planning for transmission capacity to import power into Mumbai city has been a long-pending issue. The DISCOMs have cited transmission constraints as the reason for continuing the procurement from the embedded generating stations. In our interaction with consumer representatives and MERC officials, the takeaway points that emerged are: the

delay in transmission projects is because of right-of-way issues; there is load growth in nearby districts; and the islanding scheme in Mumbai is redundant.
It is anticipated that the transmission constraints will be resolved well before Mumbai's electricity demand outgrows the city's transmission capacity for importing power.[8] MSETCL plans network augmentation based on 3 per cent year-on-year escalation in peak demand.

The islanding of Mumbai's electricity has long been seen as a technological innovation that ensured reliable supply to the city in the event of grid failures in the rest of the state (Sethi, 2017). Figure 10 shows the islanding of Mumbai. Given the fact that the city's current demand is double the existing embedded generation capacity, the islanding of the city is no longer functional.

Figure 10 - Islanding of Mumbai



Source: Sethi,2017

MSEDCL

The transmission losses incurred for supplying power to MSEDCL are assumed to be decreasing at a rate of 0.01 per cent year-on-year. In the MYT order, MERC has considered the decline in transmission loss at 0.03 per cent (ARR for MSEDCL for 3rd Control Period FY 2016-17 to FY 2019-20, 2016). Transmission losses are assumed to fall from 3.66 per cent in 2015-16 to 3.42 per cent in 2024-25.

Energy balance estimations in this study have been made from the demand side, which takes into account the transmission losses that is, the distribution losses incurred beyond the state transmission periphery. Energy balance can also be estimated from the supply side, which involves the estimation of various plant availabilities, the number of units injected from each plant, and the transmission losses incurred thereby.

[8] This is based on our interviews with consumer representatives and MERC officials.

Distribution losses for the Mumbai DISCOMs and for MSEDCL are below 15 per cent. In the case of MSEDCL, the losses projected by the DISCOM are lower than the actual losses because of misappropriation of agricultural consumption. The estimations for distribution losses for all four DISCOMs are shown in Table 11.

Table 11 - Distribution losses of Mumbai DISCOMs and MSEDCL

DISCOM	2016-17	2019-20	2024-25
BEST	5.90%	5.60%	5.10%
RIL-D	9.11%	8.36%	7.86%
TPC-D	1.12%	1.42%	1.92%
MSEDCL	13.25%	12.50%	11.50%

Source: CEEW analysis

In the case of BEST, MERC has assumed 0.10 per cent decrease in its latest MYT order, and the same has been assumed in this report, going forward. The losses approved by MERC for RIL-D are decreasing by 0.15 per cent, as per the latest MYT order. However, our estimations have assumed 0.10 per cent decrease for the same. TPC-D has an interesting distribution loss trajectory, looking ahead. The majority of the TPC-D consumers are getting HT supply, and their LT sales are likely to go up, looking ahead, which is the basis for 0.10 per cent increase in losses. The same was approved by MERC in the latest MYT order for TPC-D. In the case of MSEDCL, MERC has approved 0.25 per cent decrease in losses, and the same has been assumed, going forward.

3.2 Standby charges for Mumbai DISCOMs

The Mumbai DISCOMs avail standby support from MSEDCL, with charges payable on the standby support. The cost of electricity shall be applicable at the marginal cost of supply of MSEDCL. MERC has directed MSEDCL to levy standby charges without imposing any additional financial burden on the DISCOMs (MSEDCL's Petition seeking approval of the agreement for Standby Support by, 2009). The share of standby charges in the total revenue requirements of the DISCOMs is given in Annexure III.

3.3 Regulatory asset charges

After the operationalisation of parallel licensees in suburban Mumbai, the DISCOMs have accumulated regulatory assets.[9] The estimations projected in the ARRs of RIL-D and TPC-D were unable to capture the dynamics of changeover consumers. The assets are recovered separately as regulatory asset charges, as per MERC's order, and these charges have to be spread over a period of four years, to avoid tariff shocks, which would be a burden on consumers (Mid-term review of TPC-D, 2015).

RIL-D was allowed to levy regulatory asset charges on changeover consumers (True-up of RIL-D, 2011) as well. The changeover consumers were paying for the regulatory assets of both RIL-D and TPC-D.

In our estimations, current regulatory assets are to be recovered by FY 2019-20, as proposed by the commission in the MYT orders of DISCOMs (including MSEDCL). Going forward, the estimations assume that there will be no further regulatory assets after FY 2019-20. This is one of the reasons for the lower growth trend observed in the estimations. The share of regulatory asset charges in total revenue requirements is shown in Annexure III.

[9] Regulatory asset charges include the revenue gap as per the commission-approved ARR, unrecovered returns after true-up, and other commission-approved expenses.

3.4 Transmission charges for DISCOMs

Transmission charges form a significant portion of the cost of supply for DISCOMs. The transmission charges for DISCOMs consist of three components as given below:

i Inter-state transmission charges

ii Intra-state transmission charges

iii SLDC charges

The transmission charges shown in the tariff orders of Mumbai DISCOMs and MSEDCL are total transmission charges, including SLDC charges. The trends observed in total transmission charges show consistent growth when compared to the transmission charges observed in CEEW's Delhi analysis (Council on Energy, Environment and Water, 2017), with the transmission charges being relatively lower for all four Mumbai DISCOMs. This is because of the high demand in the state, which apportions the total transmission costs over the total units consumed.

Inter-state transmission charges are going up while transmission losses have not gone down significantly. Further, the charges will continue to go up as more and more investments are made to augment the transmission capacity. This is being done mainly to:

- evacuate renewable power from remote locations with low utilisation
- upgrade infrastructure to avoid a repeat of the 2012 blackout
- replace aged and ageing infrastructure

The costs of setting up transmission projects are going up due to increases in the costs of right of way, land, and commodity prices. Figure 11 shows the procedure for the estimation of transmission charges.

Figure 11 - Procedure for estimation of transmission charges

Inter-state charges →
Total transmission charges include PGCIL and SLDC charges

Intra-state charges →
These charges are inclusive of the SLDC charges applicable on DISCOMs

Total transmission charges
The growth rate assumed for estimation is based on the growth rate observed in the MYT orders of the respective DISCOMs

Source: CEEW assumptions for estimation of transmission charges

For the Mumbai DISCOMs and MSEDCL, the assumptions about the growth rates in the total transmission charges are given below.

i. BEST: The growth rate assumed in the latest MYT order from FY 2016-17 to FY 2019-20 is 7.3 per cent. We have assumed a conservative estimate of 5.3 per cent CAGR in transmission charges, looking ahead.

ii. RIL-D: The growth rate assumed in the latest MYT order from FY 2016-17 to FY 2019-20 is 6.1 per cent. The same has been assumed as CAGR, looking ahead.

iii. TPC-D: The growth rate observed in transmission charges from FY 2015-16 to FY 2019-20 is 9.1 per cent. The same CAGR is assumed in transmission charges, looking ahead.

iv. MSEDCL: The growth rate observed in the latest MYT order from FY 2016-17 to FY 2019-20 is 4.7 per cent. The same CAGR is assumed in transmission charges, looking ahead.

The transmission charges for all four DISCOMs are shown in Table 12.

Table 12 - Estimations of transmission charges for Mumbai DISCOMs and MSEDCL

Transmission charges (INR /kWh)	2016-17	2019-20	2024-25
BEST	0.40	0.49	0.64
RIL-D	0.35	0.45	0.57
TPC-D	0.42	0.60	0.93
MSEDCL	0.55	0.63	0.79

Source: CEEW estimations of transmission charges

The difference in transmission charges of DISCOMs for FY 2016-17 and FY 2019-20 is disproportionate. The hike approved by MERC is different for all three DISCOMs. Going forward, the same hike is assumed as the one approved in the current control period. This is because of the uncertainty in transmission capacity additions for Mumbai. For MSEDCL, on the other hand, heavy investments in transmission assets are unlikely, considering the power-surplus situation and the growth in demand. Therefore, the conservative growth rate approved in the latest control period is assumed, going forward.

3.5 Charges of DISCOMs

This study does not attempt the estimation of charges of DISCOMs, which involves the following components:

- O&M expenses
- Depreciation of distribution assets
- Return on capital expenditure
- Working capital requirements

The estimations assume the DISCOM charges to be in a constant ratio with the power procurement costs and transmission charges combined. These ratios vary for different DISCOMs. These assumptions about DISCOM charges are listed below.

i. BEST: The historical ratio of power procurement charges and transmission charges, combined, to transmission charges is 70:30. Going forward, the same ratio has been assumed.

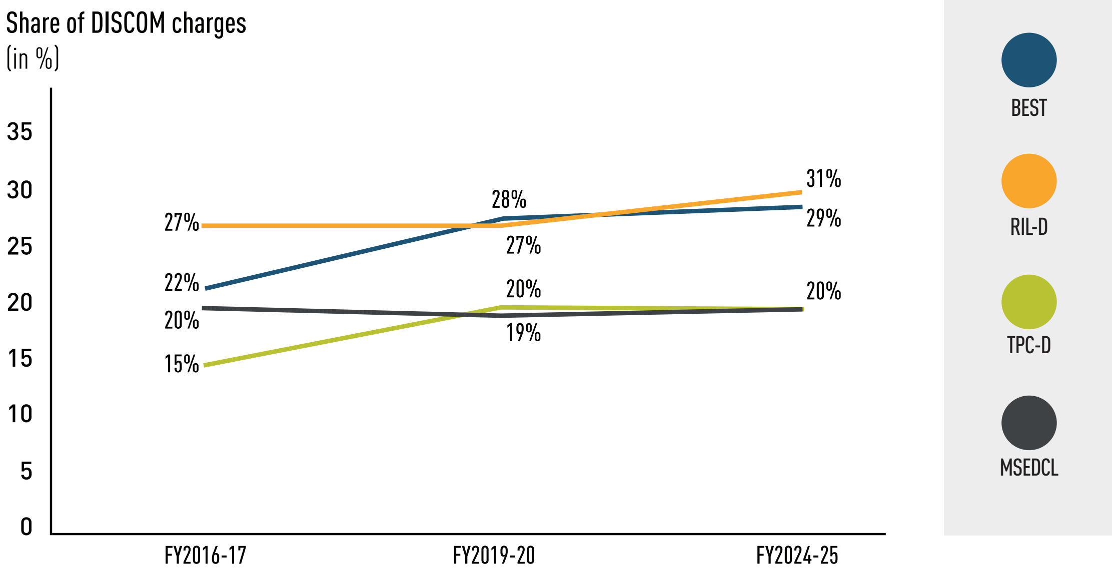
ii. RIL-D: The historical ratio is 69:30. Going forward, the same ratio has been assumed.

iii. TPC-D: The historical ratio is 79:21. Going forward, the same ratio has been assumed.

iv. MSEDCL: The historical ratio is 80:20. Going forward, the same ratio has been assumed.

Historically, O&M costs have shown consistent growth; these costs are inclusive of employee costs, maintenance costs, and administrative overheads. The growth trends for the O&M costs of Mumbai DISCOMs and MSEDCL, looking ahead, are shown in Figure 12.

Figure 12 - Share of DISCOM charges in total revenue requirement



Source: CEEW estimations of DISCOM charges and revenue requirement

In arriving at DISCOM charges, in our estimations, the ratios are assumed to be constant. However, the share of DISCOM charges (Figure12) is different from the ratios that have been assumed in the estimations. This is because of the share of standby charges (for all DISCOMs except MSEDCL) and regulatory asset charges. Further, given that the service levels of the Mumbai DISCOMs and MSEDCL are fairly good, with low technical losses, high metering, and collection efficiencies, we do not expect any significant increase in the outlay towards O&M and capacity enhancement, over and above what has been seen historically.

3.6 Cost of supply projections

Based on the assumptions laid out so far, the ACoS for Mumbai DISCOMs and MSEDCL is estimated in two energy-mix scenarios-low RE penetration and high RE penetration-for the years 2019-20 and 2024-25 (Table 13).

Table 13 - Average cost of supply for Mumbai DISCOMs

Avg. Cost of Supply (INR/KWh)		2016-17	2019-20	2024-25
BEST	Scenario I	9.38	9.26	12.12
	Scenario II		8.51	9.51
RIL-D	Scenario I	9.39	11.45	15.17
	Scenario II		10.44	10.62
TPC-D	Scenario I	7.77	7.18	9.76
	Scenario II		6.71	7.69
MSEDCL	Base Case	6.33	7.95	10.80
	Scenario I		8.01	10.52
	Scenario II		8.05	10.30

Source: CEEW estimations based on indicated assumptions

The drop in ACoS from FY 2016-17 to FY 2019-20 for BEST and TPC-D is based on the assumption of the recovery of regulatory asset charges. By FY 2019-20, the regulatory asset charges are assumed to have been recovered by the end of FY 2018-19. The growth in ACoS for RIL-D is much higher when compared to the other two Mumbai DISCOMs. This is owing to the generation mix that is assumed for both scenarios and to the hike in variable charges (mainly for coal-based generation). This indicates that RIL-D must change its procurement strategy, going forward. This is important in order for RIL-D to maintain its competitiveness as a licensee. The difference between RIL-D and TPC-D costs for FY 2024-25 shows that TPC-D could absorb all the consumers of RIL-D.

3.6.1 Uncertainties in the forecast

The assumptions made in this report are based on the data available for all four DISCOMs. The actual ACoS for the DISCOMs could vary beyond the lower and higher estimates shown in Table 13. The factors that could affect the cost (ACoS) further are rise in fuel prices, change in generation mix, increased generation tariff due to higher or unexpected expenditures (for example, the impact of salary hikes by the Pay Commission), increased capital inflow for repair and maintenance, etc.

4. Average Billing Rate (ABR)

The assumptions made in this report are based on the data available for all four DISCOMs. The actual ACoS for the DISCOMs could vary beyond the lower and higher estimates shown in Table 13. The factors that could affect the cost (ACoS) further are rise in fuel prices, change in generation mix, increased generation tariff due to higher or unexpected expenditures (for example, the impact of salary hikes by the Pay Commission), increased capital inflow for repair and maintenance, etc.

The ACoS is not the tariff that is payable by consumers. Some categories of consumers cross-subsidise the cost of supply for the other categories of consumers. The impact of subsidies on the tariff for each consumer category can be seen from the ABR to ACoS ratio. ABR is the actual billing rate applicable for each category of consumers.

The ABR values are derived from the category-wise revenues available to the DISCOM. ABR comprises fixed and energy charges, which are reflected in the electricity bills of the consumers as per their contracted demand. The formula for the ABR calculation is:

ABR (for a particular consumer category) = **Revenue** expected from the respective category in INR (given in the tariff order)/**Approved sales** in MU (given in the tariff order)

For example, if INR 100 crore in revenues is expected from the industrial category consumer of a DISCOM, and if the approved sales are 100 MU for the same year, then the ABR is:

= 100*10/100

= INR 10/kWh

The forward-looking estimation of ABR rests on how the cross-subsidy changes over time. In each of the scenarios (described in section 3.1.2), there is an added assumption on the nature of variation of the cross-subsidy. The historical trends of the ABR to ACoS ratio for select categories of all four DISCOMs are shown in Annexure IV.

The ABR to ACoS ratios for C&I consumers are projected for the scenarios discussed in section 3.1. The ratios are an extension of the assumptions on energy mix and fuel price escalations. The assumptions for each scenario are given below:

i. BEST: The ABR to ACoS ratio in scenario I, for FY 2019-20, is assumed to remain the same as the projections in the latest MYT order of BEST. This ratio is assumed to remain the same till FY 2024-25. In scenario II, the ratio up to 2019-20 is the same as in scenario I, for FY 2024-25. This ratio is assumed to come to 105 per cent for all categories.

ii. RIL-D: The ABR to ACoS ratio in scenario I, for FY 2019-20, is assumed to remain the same as the projections in the latest MYT order of RIL-D. This ratio is assumed to remain the same till FY 2024-25. In scenario II, the ratio up to 2019-20 is the same as in scenario I, for FY 2024-25. This ratio is assumed to come to 105 per cent for all categories.

iii. TPC-D: The ABR to ACoS ratio in scenario I, for FY 2019-20, is assumed to remain the same as the projections in the latest MYT order of TPC-D. This ratio is assumed to remain the same till FY 2024-25. In scenario II, the ratio up to 2019-20 is the same as in scenario I. For FY 2024-25, this ratio is assumed to be 105 per cent for all categories.

iv. MSEDCL: The ABR to ACoS ratio in scenario I, for FY 2019-20, is assumed to remain the same as the projections in the latest MYT order of MSEDCL. This ratio is assumed to decline to 150 per cent by FY 2024-25. In scenario II, the ratio is assumed to fall to 120 per cent by FY

2024-25. The ratios for FY 2019-20 are assumed to follow this trajectory. In the base case scenario, the ABR to ACoS ratio is assumed as per the current ratio. The same ratio has been assumed till FY 2024-25.

In scenario II, the expectation is for some rationalisation of the cross-subsidy and for an implicit reform of tariff across consumer categories. However, the political economy of such bold reforms would dictate the pace of such changes. The rationalisation in each of the scenarios reflects the higher and lower ranges of the estimated tariffs, or a best-and worst-case scenario, looking ahead.

Based on the above scenarios and assumptions, the ABR for the C&I consumer category is estimated. Table 14 shows the ABR for TPC-D, RIL-D, and MSEDCL. Growth in ABR is not as high in the case of TPC-D or MSEDCL as in the case of RIL-D. This is mainly because of the assumptions for the generation mix and the hike in the variable charges of coal, contributing to the rise in tariff. In absolute terms, the growth in tariffs is not high, because of zero regulatory charges, assumed between FY 2019-20 and FY 2024-25.

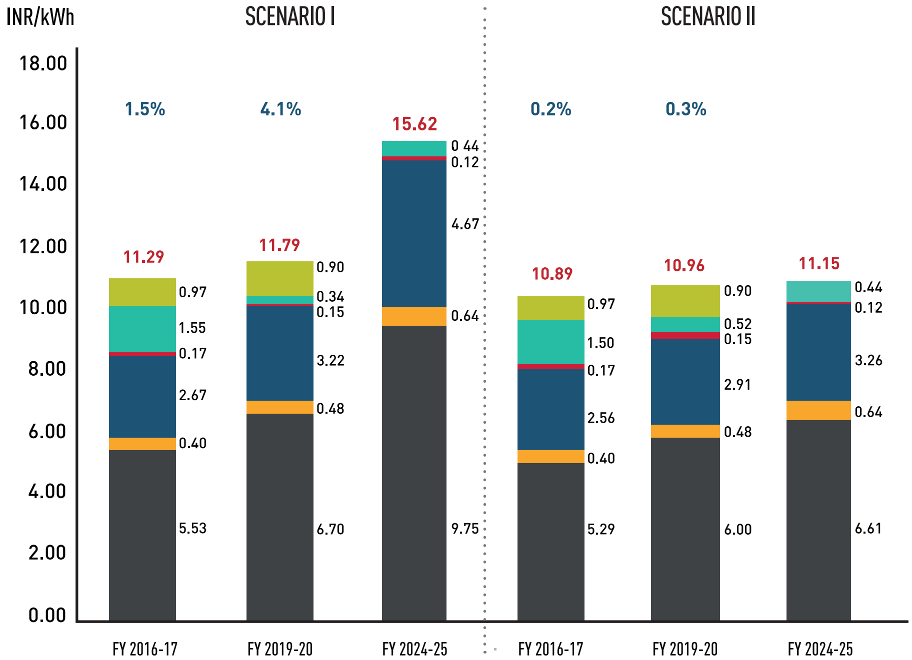
Table 14 - ABR for TPC-D, and MSEDCL

DISCOMs	Particulars	2019-20		2024-25	
		Commercial	Industrial	Commercial	Industrial
RIL-D	Scenario I	12.48	11.79	16.53	15.63
	Scenario II	11.38	10.96	11.15	11.15
TPC-D	Scenario I	8.41	8.26	11.41	11.22
	Scenario II	7.85	7.72	8.07	8.07
MSEDCL	Base Case	15.35	11.45	20.85	15.56
	Scenario I	14.17	11.54	15.78	15.15
	Scenario II	13.32	10.86	12.36	12.36

Source: CEEW estimations

The estimates show that the increasing tariffs are evened out by the decreasing ABR to ACoS ratio. Despite the increased penetration of low-cost RE sources, the ACoS is seen to be increasing. However, this increase does not translate into an increase in tariff for the C&I category on account of the rationalisation of cross-subsidy (a tapering or lower ABR to ACoS ratio), as shown in Figures 13, 14, 15, and 16. The ABR for the C&I consumers of RIL-D, TPC-D, and MSEDCL, in tabular form, is given in Annexure IV.

Figure 13 - ABR for industrial consumers of RIL-D



Source: CEEW estimates

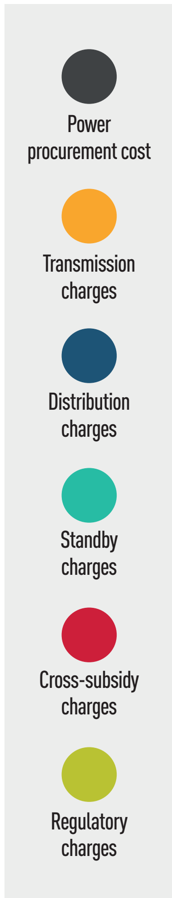
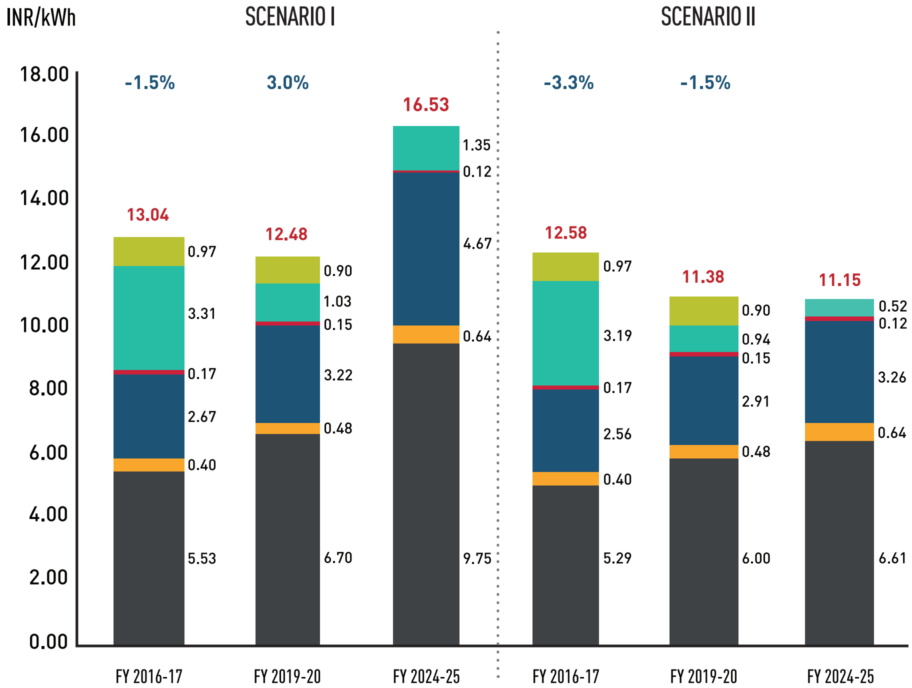
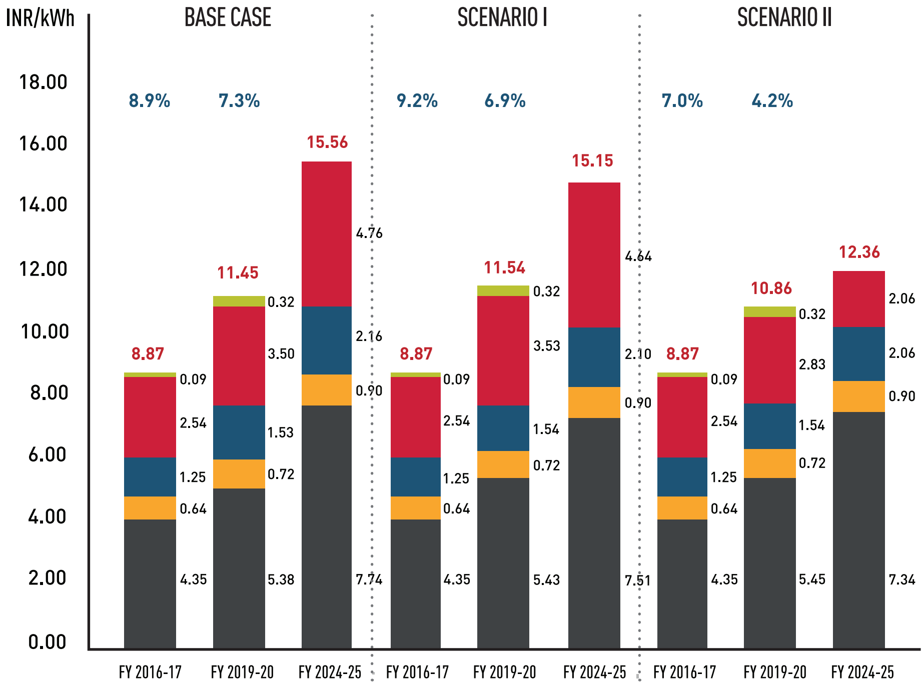


Figure 14 - ABR for commercial consumers of RIL-D



Source: CEEW estimates

Figure 15 - ABR for industrial consumers of MSEDCL



Source: CEEW estimations based on indicated assumptions

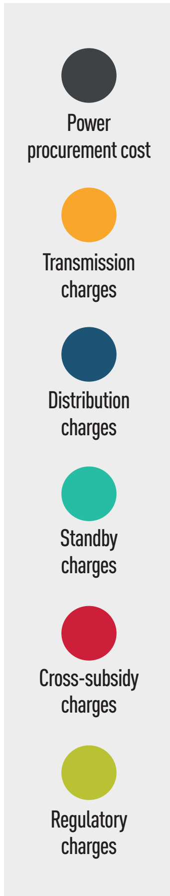
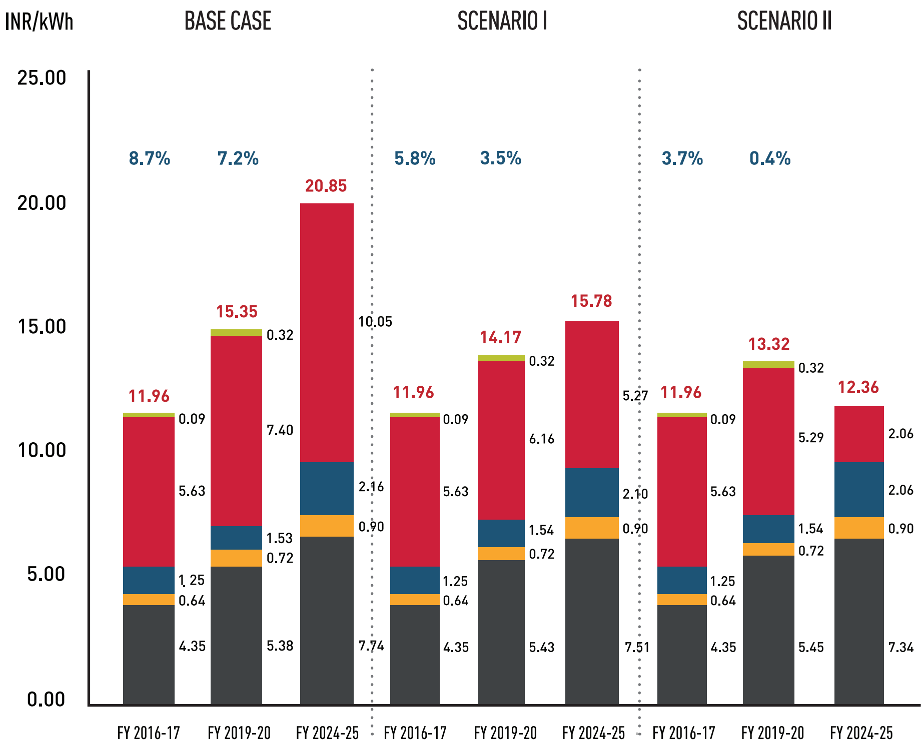


Figure 16 - ABR for commercial consumers of MSEDCL



Source: CEEW estimations based on indicated assumptions

5. Lessons from Retail Tariff Estimations

The Council took up the exercise of estimating retail supply tariffs in three states - Delhi, Karnataka, and Maharashtra. This project was completed in two phases, as given below.

i. Phase 1: Estimation of retail tariffs for Delhi state - covers the three main DISCOMs of Delhi: Tata Power Delhi Distribution Ltd (TPDDL), BSES Rajdhani Power Ltd (BRPL), and BSES Yamuna Power Ltd (BYPL)

ii. Phase 2: Estimation of retail tariffs for Bengaluru Electricity Supply Company Ltd (BESCOM). Estimation of retail tariffs for Mumbai city – covers the main DISCOMs of Mumbai: BEST, RIL-D, and TPC-D, and also for MSEDCL.

It was an important learning experience to observe the diverse set of factors affecting the retail supply tariffs for the different DISCOMs. In this context, a short summary of the diverse factors affecting retail tariffs across DISCOMs is given below.

i. Power procurement costs: The power procurement of a DISCOMs is based on the energy mix, purchase planning (share of long-term PPAs in power procurement), and cost of power purchase. The Delhi DISCOMs have to import most of their power from central generating stations and from independent power producers (IPPs). Other than the Badarpur, Indraprastha, and Pragati gas stations, there is no generating station within Delhi. The position of the Mumbai DISCOMs is relatively better. Their embedded generating stations can cater to about half of their current demand. BESCOM and MSEDCL enjoy a diverse energy mix, with options to procure from current and upcoming RE generating stations. The estimation of power purchase costs is given in Table 11.

Table 15 - Power purchase costs for low-RE scenario of DISCOMs

Transmission costs (INR/kWh)	SCENARIO I		SCENARIO II	
	FY 2019-20	FY 2024-25	FY 2019-20	FY 2024-25
TPDDL	6.35	8.55	6.28	8.27
BRPL	6.51	8.62	6.51	8.34
BYPL	6.51	8.67	6.94	9.49
BESCOM	4.96	6.91	5.02	6.75
BEST	5.56	7.65	5.04	5.83
RIL-D	6.7	9.75	6	6.61
TPC-D	4.85	6.53	4.48	4.9
MSEDCL	5.43	7.51	5.45	7.34

Source: CEEW estimations

The difference in the power purchase costs for the Delhi DISCOMs and others is evident. This difference can be attributed to a lack of generation options within Delhi. Limited land availability has in turn constrained the RE options of the Delhi DISCOMs.

ii. Transmission costs: The transmission costs vary across DISCOMs. These are largely dependent on the share of power imported from central generating stations, the share of power imported from other states/regions, the anticipated network augmentation, and the quantum of electricity consumed in the DISCOM area. Table 12 captures the variation in transmission costs across DISCOMs.

Table 16 - Transmission costs of DISCOMs

Power purchase costs (INR/kWh)	FY 2016-17	FY 2019–20	FY 2024–25
TPDDL	1.03	1.02	1.21
BRPL	0.93	1.05	1.30
BYPL	1.13	1.13	1.34
BESCOM	0.53	0.72	0.86
BEST	0.44	0.55	0.70
RIL-D	0.40	0.48	0.64
TPC-D	0.44	0.63	0.98
MSEDCL	0.64	0.72	0.90

Source: CEEW estimations

iii. Distribution costs: DISCOM expenses or distribution costs are based on the consumer base, the consumer mix, and the status of metering and collection. The consumer mix of Delhi DISCOMs and Mumbai DISCOMs is similar, which is largely a metered urban set of consumers, with little or no agricultural consumption. BESCOM and MSEDCL, on the other hand, cater to a diverse set of urban and rural consumers, which include agricultural and industrial consumers. Table 13 captures the variation in distribution costs across DISCOMs.

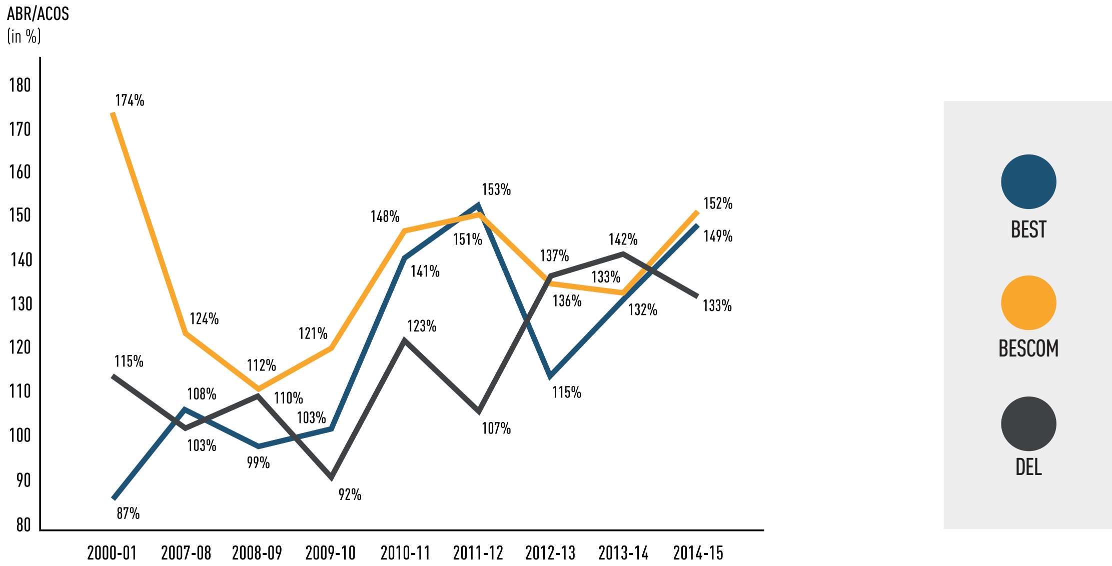
Table 17 - Distribution costs for low-RE scenario of DISCOMs

Transmission costs (INR/kWh)	SCENARIO I		SCENARIO II	
	FY 2019-20	FY 2024-25	FY 2019-20	FY 2024-25
TPDDL	1.84	2.44	1.87	2.37
BRPL	1.89	2.48	1.87	2.41
BYPL	1.5	1.55	1.52	1.56
BESCOM	1	1.36	1.02	1.34
BEST	2.62	3.58	2.39	2.8
RIL-D	3.22	4.67	2.91	3.26
TPC-D	1.46	2	1.36	1.56
MSEDCL	1.54	2.1	1.54	2.06

Source: CEEW estimations

iv. Cross-subsidy charges: The consumers most affected by the cross-subsidy charges are the C&I consumers, who are subsidising the domestic and agricultural consumers. In our estimations, we have assumed a decreasing ABR to ACoS ratio. This is one of the reasons for the lower increase in tariffs across DISCOMs. The cross-subsidy charges are also dependent on the revenues expected from each category of consumer. Historically, cross-subsidy charges have shown an increasing trend. This is reflected in the ABR to ACoS ratio for MSEDCL, Delhi DISCOMs (aggregate ratio for all three DISCOMs), and BESCOM, as shown in Figure 17.

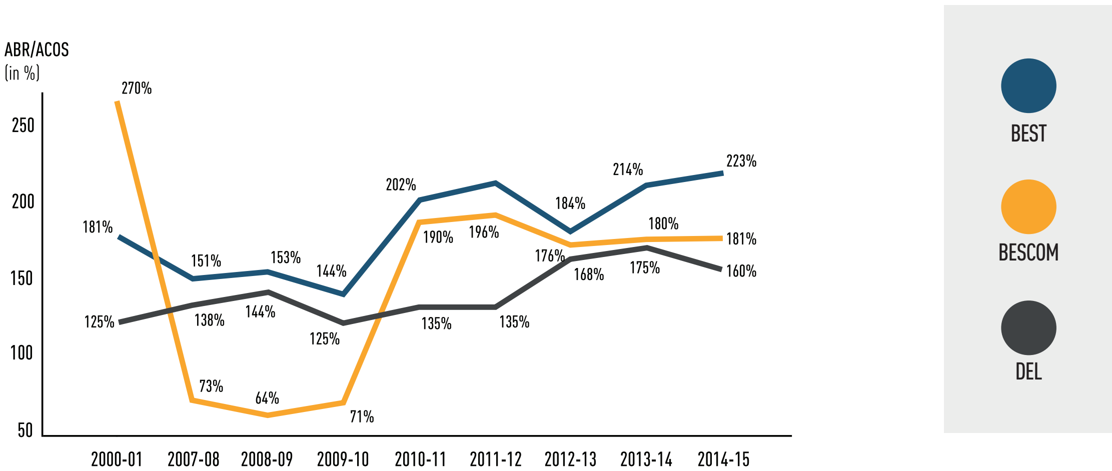
Figure 17 – Historical trends for cross-subsidies paid by industrial consumers



Source: Report on the Performance of State Power Utilities (multiple years), Power Finance Corporation Ltd

The first data point on the x-axis in Figure 17 is for FY 2000-01. This is shown to highlight the difference in cross-subsidies in different time scales. Although there is no steady trend, the ratio has been growing since FY 2007-08. A similar trend of cross-subsidies to commercial consumers is shown in Figure 18.

Figure 18 – Historical trends for cross-subsidies paid by commercial consumers



Source: Report on the Performance of State Power Utilities (multiple years), Power Finance Corporation Ltd

The level of cross-subsidisation for commercial consumers is higher than that for industrial consumers. In the face of various recommendations emanating from tariff policies and regulatory orders, the cross-subsidies have remained high, to cover for the revenue gaps of DISCOMs. DISCOMs will find it difficult to retain C&I consumers if they continue to levy such heavy cross-subsidies. Therefore, we have assumed the rationalisation of tariffs, going forward. To depict a range of future tariffs, the assumptions in both scenarios include partial rationalisation and complete rationalisation in scenario 1 and scenario II respectively. Table 14 captures the cross-subsidy charges for the commercial category consumers of the different DISCOMs.

DISCOMs will find it difficult to retain C&I consumers if they continue to levy such heavy cross-subsidies

Table 18 - Cross-subsidy for commercial consumers in low-RE scenario of DISCOMs

Transmission costs (INR/kWh)	SCENARIO I		SCENARIO II	
	FY 2019-20	FY 2024-25	FY 2019-20	FY 2024-25
TPDDL	2.21	2.44	2.03	0
BRPL	2.1	2.48	1.61	0
BYPL	2.29	2.5	2.09	0
BESCOM	2.85	3.9	2.2	1.79
BEST	0.78	1.45	0.49	0.29
RIL-D	1.03	1.35	0.94	0.54
TPC-D	0.32	1.66	0.23	0.39
MSEDCL	5.16	5.27	5.29	2.06

Source: CEEW estimations

MSEDCL levies heavy cross-subsidy charges on its consumers to subsidise agricultural and domestic consumers in the state. It is important to note that all DISCOMs (except MSEDCL) that are under consideration here mostly serve urban areas. Low cross-subsidies in Mumbai are an exception. This is because of the level of metering and billing efficiencies of the DISCOM. Further, Mumbai consumers pay their bills for the reliable supply of electricity, which is assured by the DISCOM. On the other hand, for MSEDCL, which also ensures that no load shedding occurs in most of the state, ensuring supply to remote agricultural consumers is a cost. These costs, apart from subsidies to domestic consumers, are recovered from C&I consumers.

In the case BEST, decreasing trend of cross subsidies in Scenario I is owing to high amount of charges payable towards regulatory assets, this is assumed to be completed by FY 2019-20. The opposite trend is observed in Scenario II because of reduced ABR to ACoS ratio assumed, going forward.

6. Conclusions

6.1 Cost of supply

The cost of supply has been increasing significantly (6.5 per cent increase annually) and is expected to continue to rise in the future. However, this increasing cost of supply cannot be realised in the tariff owing to an expected decrease in the cross-subsidy charge.

6.2 Cross-subsidisation - a key factor

The actual tariff levied on consumers is different for different categories. Cross-subsidising domestic consumers is a common practice in many states. In Maharashtra, historically, the ABR to ACoS ratio has been uneven across all consumer categories (based on data from FY 2013-14 to FY 2015-16). Still, C&I consumers have been paying for the majority of the subsidies to domestic and agricultural consumers.

The report by the Forum of Regulators of CERC (Forum of Regulators and PwC, 2015) also suggests following multiple methods to estimate cost of supply and doing away with cross-subsidies in all states. It is important to note that the National Tariff Policy (set by the Ministry of Power) has mandated the states to bring down cross-subsidies to within +/-20 per cent of ACoS. Although some states have managed to bring down cross-subsidies to within +/-20 per cent of ACoS, it is unlikely that this trend will be picked up across the country.

6.3 Role of renewable energy in forecasting

It is envisaged that renewable sources, primarily solar, wind, and biomass could play a key role in conforming with, or differing from, the forecasts in this study. Multiple scenarios have been assumed to accommodate this deliberate shift to renewables. However, the targets for renewables (a target of 175 GW capacity addition by 2022) are ambitious, and there is uncertainty about reaching these targets. The cost of renewables also plays a major role in future energy choices; grid parity is a likely scenario in the next decade. Hence, all these factors could play a major role in the development and evolution of future energy markets.

6.4 Regulatory uncertainties in tariff design

The forecasting exercise undertaken in this report does not take into account all the elements, as is considered by any regulatory commission. Some of these elements are dependent on extraneous factors like hike in the salaries of government employees, failure to disburse timely payments by DISCOMs, rate of depreciation, sudden surges in fuel prices, or hikes in the green cess for thermal power plants. These complications are inherent in tariff estimations. Further, they are subject to human decision-making, which could be based on factors that are extraneous to data-based rationales. It is important to take cognisance of these uncertainties before using the results of this exercise.

7. Remarks from Stakeholder Discussions on the Future of Retail Tariffs for C&I Consumers

Based on discussions with various stakeholders (mainly C&I consumers) on the future of retail tariffs, the issue of cross-subsidy surcharge was identified as the major issue for C&I consumers. The state regulatory orders on the issue of cross-subsidy lack consistency. This adds to the uncertainty about the future energy costs of C&I consumers. The share of HT C&I consumers has dropped over the last decade. The current level of cross-subsidisation does not encourage the growth of industrial and commercial activity in the country.

Observations and suggestions from the stakeholders were focused on assigning accountability for electricity consumption for agricultural consumers. One suggestion was to replace electricity subsidies to DISCOMs with direct-benefit mechanisms to farmers. This will help bring down the cross-subsidy charges on C&I consumers.

Finding alternatives and options to DISCOM supply was one of the major talking points. In the case of C&I consumers, it makes commercial sense to explore options that bring about more certainty regarding their energy costs. In conclusion, the stakeholders sought more certainty about future electricity tariffs to facilitate better planning regarding costs.

Some observations on open access and short-term purchases of DISCOMs are presented below.

Observations on short-term purchases of Mumbai DISCOMs: The strategy of purchasing power from exchanges is considerably risky; hence customers should not adopt this strategy given the uncertainty of exchange prices. The volume of the total power traded in the exchanges is very low, and short-term prices are lower than long-term price trends, which indicates the shallowness of the market. Exchange prices can shoot up dramatically, wiping out past savings from open access (OA). OA consumers are lower on the supply priorities of DISCOMs and are likely to be first in line for load shedding in case of any grid challenges or in case of any network failures or congestion

Observations and suggestions from the stakeholders were focused on assigning accountability for electricity consumption for agricultural consumers

Observations on open access (OA): The cost arbitrage of OA is only in the short run. Regulatory commissions are actively considering increasing the proportion of fixed charges so that the difference between tariff and exchange prices is reduced and thereby the attractiveness of OA is reduced. OA has become attractive due to the change in the cross-subsidy formula. This change will increase the revenue gaps for DISCOMs, leading to an accumulation of regulatory assets. The regulatory assets along with the carrying cost add to the burden of commercial consumers. Therefore, whatever cost benefits are seen in OA are likely to be short lived.

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Annexures

Annexure I

Energy sales estimations for BEST and TPC-D are given below.

Table - Energy sales estimations for different categories of consumers for BEST (in MU)

Particulars*	FY 2011-12	FY 2016-17	Avg. sales from FY 2010–11 to FY 2016–17	% share of Avg. of consumer category sales	FY 2019–20	FY 2024–25
Domestic	1,739	1,974	1,847	41%	2,096	2,337
Non-Domestic	1,923	1,993	1,976	44%	2,069	2,190
Industrial	290	354	326	7%	394	488
Total consumption (including other categories)	4,065	4,763	4,459		4,973	5,768

Source: CEEW estimations, from ARR documents of respective DISCOMs

** All figures are total of HT and LT sales for the respective category*

Table - Energy sales estimations for different categories of consumers for BEST (in MU)

Particulars*	FY 2011-12	FY 2016-17	Avg. sales from FY 2010–11 to FY 2016–17	% share of Avg. of consumer category sales	FY 2019–20	FY 2024–25
Domestic	117	250	180	5%	321	545
Non-Domestic	864	965	936	25%	1,042	1,214
Industrial	1,188	1,037	1,262	33%	1,120	1088
Total consumption (including other categories)	3,033	4,915	3,806		5,271	5,780

Source: CEEW estimations, from ARR documents of respective DISCOMs

** All figures are total of HT and LT sales for the respective category*

Annexure II

The fixed and variable components of generation tariff from different fuels have increased as follows:

Power purchase costs of different [energy? fuel?] sources (INR /kWh)

Particulars	FY 2015–16	FY 2016–17	FY 2017–18	FY 2018–19	FY 2019–20	FY 2020–21	FY 2021–22	FY 2021–22	FY 2021–22	FY 2021–22
Coal	3.41	3.72	4.06	4.43	4.83	5.27	5.75	6.27	6.84	7.47
Gas	3.88	4.12	4.38	4.65	4.94	5.24	5.57	5.91	6.28	6.67
Nuclear	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.61
Hydro	1.90	1.92	1.95	1.98	2.00	2.03	2.05	2.08	2.11	2.13
Renewables	5.77	5.48	5.21	4.95	4.70	4.46	4.24	4.03	3.83	3.64
Open access	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92

Source: Tariff orders of CIL for respective years

Thermal generation (coal and gas)

The fixed component for a coal power plant represents about 30 per cent of total generation tariff. The variable component, which consists of fuel charges, is about 70 per cent of total generation tariff. Similarly, for gas-based generation, the fixed and variable components are about 45 per cent and 65 per cent of total generation tariff respectively.

CERC has specified the "energy charge rate" formula to translate fuel cost into per unit cost of electricity generation (variable component). The variable component is directly proportional to the fuel charges; any increase in fuel cost will increase the variable charges by the same percentage. Hence, to estimate the future generation tariff for coal- and gas-based plants, variable components are forecasted based on the expected increase in coal and gas prices.

- For coal plants, 9.1 per cent annual increase in coal price is assumed based on previous coal tariff orders released by Coal India Limited. Going forward, India is likely to be less dependent on imported coal, so it is safe to consider the estimates of fuel price increases available from Coal India Limited.
- For gas plants, 6.2 per cent annual increase is considered based on gas prices in the international market since India is largely reliant on imported gas.

Cost of Coal based on calorific value band

GCV (Gross calorific value) bands (Kcal/Kg)	INR /Tonne				CAGR
	2012	2013	2014	2016	
>7000	*			*	
>6700 and < 7000	4,870	4,870	4,870	3,450	-6.7%
>6400 and < 6700	4,420	3,890	3,890	3,210	-6.2%
>6100 and < 6400	3,970	3,490	3,490	3,000	-5.4%
>5800 and < 6100	2,800	2,800	2,800	2,750	-0.4%
>5500 and < 5800	1,450	1,600	1,920	2,280	9.5%
>5200 and < 5500	1,270	1,400	1,680	1,920	8.6%
>4900 and < 5200	1,140	1,250	1,510	1,700	8.3%
>4600 and < 4900	880	970	1,170	1,320	8.4%
>4300 and < 4600	780	860	1,030	1,180	8.6%
>4000 and < 4300	640	700	840	970	8.7%
>3700 and < 4000	600	660	800	910	8.7%
>3400 and < 3700	550	610	730	860	9.4%
>3100 and < 3400	500	550	670	780	9.3%
>2800 and < 3100	460	510	610	720	9.4%
>2500 and < 2800	410	450	550	640	9.3%
>2200 and < 2500	360	400	480	560	9.2%

Source: Tariff orders of CIL for respective years

** For GCV exceeding 7000 Kcal/Kg, the price shall be increased by Rs 150/- per tonne over and above the price applicable for the GCV band exceeding 6700 Kcal/Kg but not exceeding 7000 Kcal/Kg, for increase in GCV by every 100 Kcal/Kg or part thereof.*

Hydro generation

For hydro stations, even though there is no fuel expenditure, tariff is nevertheless still divided into fixed and variable components in a ratio of about 50:50. For estimating the escalation of generation tariff for hydro stations, the tariff approved by CERC for 2015-16 to 2018-19 is used for calculations. For the remaining years, from 2019-20 to 2024-25, a similar annual increase is considered as per the following table.

Plant	2015-16	2016-17	2017-18	2018-19
Sardar Sarovar Project (SSP)	2.05	2.05	2.05	2.05
Pench	2.05	2.05	2.05	2.05
Dodson	2.65	2.29	2.33	2.41

Source: CERC approved tariffs for respective plants

Nuclear generation

Nuclear power plants have a single part tariff. There is no variable component. The escalation in generation tariff is assumed to remain the same, as per the tariff approved by CERC for nuclear power plants supplying to MSEDCL.

Plant	2016-17	2017-18	2018-19	2019-20
NPCIL (Tarapur and Kaiga nuclear power plants)	2.41	2.41	2.35	2.41

Source: CERC approved tariffs for respective plants

Solar generation

Solar prices are expected to decrease by 5-6 per cent annually given the anticipated efficiency gains and the forecasted reduction in costs. These rates are in line with the long-term decline in the tariff of solar power generation. The same is assumed in estimating the future purchase cost from solar plants.

Year	Weighted Average Tariff
2010	12.16
2011	8.79
2012	8.23
2013	7.38
2014	6.49
2015	5.61
2016	4.43

Source: CEEW analysis based on individual bids for solar, for respective years

Annexure III

The share of standby charges in the total revenue requirements of the Mumbai DISCOMs is shown in the table below.

Table – Share of standby charges in total revenue requirements

DISCOM	2016-17	2019-20	2024-25
BEST	2.44%	2.54%	2.04%
RIL-D	1.85%	1.59%	1.35%
TPC-D	2.82%	3.57%	2.97%

Source: CEEW estimations and latest MYT orders of respective DISCOMs

The share of regulatory asset charges in the total revenue requirements of the Mumbai DISCOMs is shown in the table below.

Table – Share of regulatory asset charges in total revenue requirement

DISCOM	2016-17	2019-20
BEST	24.32%	4.10%
RIL-D	10.51%	9.73%
TPC-D	23.84%	-
MSEDCL	1.40%	4.10%

Source: Latest MYT orders of respective DISCOMs

Annexure IV

The breakdown of the ABR components for C&I consumers of RIL-D is given below:

Commercial (INR /kWh)		2016-17	2019-20	2024-25
Scenario I	Power purchase costs	5.53	6.70	9.75
	Transmission charges	0.40	0.48	0.64
	Distribution charges	2.67	3.22	4.67
	Standby charges	0.17	0.15	0.12
	Cross-subsidy charges	3.30	1.03	1.35
	Regulatory assets	0.97	0.90	-
	Total	**13.04**	**12.48**	**16.53**
Scenario II	Power purchase costs	5.29	6.00	6.61
	Transmission charges	0.40	0.48	0.64
	Distribution charges	2.56	2.91	3.26
	Standby charges	0.17	0.15	0.12
	Cross-subsidy charges	3.19	0.94	0.52
	Regulatory assets	0.97	0.90	-
	Total	**12.58**	**11.38**	**11.15**

Source: CEEW analysis

Industrial (INR /kWh)		2016-17	2019-20	2024-25
Scenario I	Power purchase costs	5.53	6.70	9.75
	Transmission charges	0.40	0.48	0.64
	Distribution charges	2.67	3.22	4.67
	Standby charges	0.17	0.15	0.12
	Cross-subsidy charges	1.55	0.34	0.44
	Regulatory assets	0.97	0.90	-
	Total	**11.29**	**11.79**	**15.62**
Scenario II	Power purchase costs	5.29	6.00	6.61
	Transmission charges	0.40	0.48	0.64
	Distribution charges	2.56	2.91	3.26
	Standby charges	0.17	0.15	0.12
	Cross-subsidy charges	1.50	0.52	0.52
	Regulatory assets	0.97	0.90	-
	Total	**10.89**	**10.96**	**11.15**

Source: CEEW analysis

The breakdown of the ABR components for C&I consumers of TPC-D is given below:

Commercial (INR /kWh)		2016-17	2019-20	2024-25
Scenario I	Power purchase costs	3.96	4.85	6.53
	Transmission charges	0.44	0.63	0.98
	Distribution charges	1.17	1.46	2.00
	Standby charges	0.23	0.25	0.24
	Cross-subsidy charges	2.46	0.32	1.66
	Regulatory assets	0.97	0.90	-
	Total	**9.79**	**8.41**	**11.41**
Scenario II	Power purchase costs	3.96	4.48	4.90
	Transmission charges	0.44	0.63	0.98
	Distribution charges	1.17	1.36	1.56
	Standby charges	0.23	0.25	0.24
	Cross-subsidy charges	2.46	0.23	0.39
	Regulatory assets	0.97	0.90	-
	Total	**9.67**	**7.85**	**8.07**

Source: CEEW analysis

Industrial (INR /kWh)		2016-17	2019-20	2024-25
Scenario I	Power purchase costs	3.96	4.85	6.53
	Transmission charges	0.44	0.63	0.98
	Distribution charges	1.26	1.46	2.00
	Standby charges	0.23	0.25	0.24
	Cross-subsidy charges	1.55	1.07	1.47
	Regulatory assets	1.96	-	-
	Total	**9.32**	**8.26**	**11.22**
Scenario II	Power purchase costs	3.96	4.48	4.90
	Transmission charges	0.44	0.63	0.98
	Distribution charges	1.17	1.36	1.56
	Standby charges	0.23	0.25	0.24
	Cross-subsidy charges	1.56	1.00	0.39
	Regulatory assets	1.96	-	-
	Total	**9.32**	**7.72**	**8.07**

Source: CEEW analysis

The breakdown of the ABR components for C&I consumers of MSEDCL is given below:

Commercial (INR /kWh)		2016-17	2019-20	2024-25
Scenario I	Power purchase costs	4.35	5.43	7.51
	Transmission charges	0.64	0.72	0.90
	Distribution charges	1.25	1.54	2.10
	Standby charges	-	-	-
	Cross-subsidy charges	5.63	6.16	5.27
	Regulatory assets	0.09	0.32	-
	Total	**11.96**	**14.17**	**15.78**
Scenario II	Power purchase costs	4.35	5.45	7.34
	Transmission charges	0.64	0.72	0.90
	Distribution charges	1.25	1.54	2.06
	Standby charges	-	-	-
	Cross-subsidy charges	5.63	5.29	2.06
	Regulatory assets	0.09	0.32	-
	Total	**11.96**	**13.32**	**12.36**

Source: CEEW analysis

Industrial (INR /kWh)		2016-17	2019-20	2024-25
Scenario I	Power purchase costs	4.35	5.43	7.51
	Transmission charges	0.64	0.72	0.90
	Distribution charges	1.25	1.54	2.10
	Standby charges	-	-	-
	Cross-subsidy charges	2.54	3.53	4.64
	Regulatory assets	0.09	0.32	-
	Total	**8.87**	**11.54**	**15.15**
Scenario II	Power purchase costs	4.35	5.45	7.34
	Transmission charges	0.64	0.72	0.90
	Distribution charges	1.25	1.54	2.06
	Standby charges	-	-	-
	Cross-subsidy charges	2.54	2.83	2.06
	Regulatory assets	0.09	0.32	-
	Total	**8.87**	**10.86**	**12.36**

Source: CEEW analysis


Image: Pexels

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