



Insights on Sales Forecasting

A Review of Regulatory Frameworks and Discoms Practices

July 2024

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1. Introduction

Electricity demand estimation is crucial to enable optimal power generation, transmission and distribution grid expansion. In India, the Central Electricity Authority (CEA) is the apex body which regularly undertakes the exercise of medium- and long-term demand estimation for states and discoms through the Electric Power Survey (EPS). The EPS forecasts annual electricity demand for five years on an annual basis using the partial end-use method. The Electricity Regulatory Commission (ERC) and distribution companies are guided by the EPS estimates. Yet, in the past¹ it has been observed that there are significant variations in the EPS projections and actual electricity demand. CEA has recently published guidelines for medium- and long-term demand estimation in utilities with the aim to bring uniformity in approach.

Electricity distribution companies (Discoms) on the other hand are also required to undertake rigorous task of demand estimation which forms the basis for resource planning i.e., power procurement and network expansion. Discoms undertake demand i.e., sales and loss estimation for short and medium term as a process of the annual revenue requirement (ARR) and multi-year (MYT) tariff process as mandated by respective State ERCs.² It is observed that there is significant variation in the method and data used by discoms for the process of sales estimations. In this article, we present an overview of different approaches prescribed by state regulations and practices adopted by discoms for sales estimation. We hope this comparative analysis provides direction for adoption of better sales estimation techniques across states.

The article covers notified MYT regulations for 28 states (including Delhi)³ & 5 UTs, ARR Petitions and Tariff Orders of 62 discoms. The terms Sales estimation- Sales forecast- Sales Projection have been used interchangeably across MYT regulations and tariff petitions. Sales estimation methods for a few union territories and Sikkim state have not been covered owing to unavailability of recent documents. The article presents details of the different methods suggested by MYT

¹ <https://energy.prayas.pune.org/our-work/research-report/the-price-of-plenty-insights-from-surplus-power-in-indian-states>

² SERCs, Terms and Conditions for Multi-Year Tariff (MYT) Determination for Distribution Retail Supply, Regulations

³ Delhi is considered as state, having its own ERC. States – Manipur and Mizoram have one Joint ERC. JERC regulates state of Goa and UTs.

regulations, an overview of the methods and data used by discoms and best practices adopted by some of them.

2. Sales Estimation Approach suggested in Regulations

Most MYT Regulations provide direction on the approach, factors, time period and methods that shall be used by discoms for sales estimation. Table 1 provides an overview of the different factors included in these regulations. Excerpts from MYT regulations of Maharashtra Electricity Regulatory Commission, Joint Electricity Regulatory Commission (JERC) and Andhra Pradesh are included here to provide a quick snapshot of the persuasive directions included in the regulations.

MERC MYT Regulations, 2019 (82.1) "The Distribution Licensee shall submit a month-wise forecast of the expected sales of electricity to each Tariff category/sub-category and to each Tariff slab within such Tariff category/sub-category to the Commission."

JERC MYT Regulations, 2021 (8.6 (a)) "The Distribution Licensee shall forecast sales for each Consumer category and subcategories, at different voltage levels, for each Year of the Control Period."

APERC MYT Regulations, 2018 (10.10) (4) "The forecast for the ensuing year shall be on monthly basis to properly capture the seasonality in demand."

Table 1: Summary of the sales projections approach defined by SERCs & JERC⁴.

Approach and Factors mentioned in MYT regulations for Sales Projections ⁵	No. of SERCs that have defined - Out of 27 SERCs considered for review
Consumer (sub) category-wise projections / Tariff (sub) category-wise projections	All SERCs
Impact of Energy consumption, energy efficiency and energy conservation measures	All SERCs
Impact of Economic growth, social, technology, climate change and other factors	All SERCs
OA transaction details are to be separately furnished	12 SERCs and JERC (Tripura, Bihar, Himachal Pradesh, Jharkhand, Odisha, Tamil Nadu, Madhya Pradesh, West Bengal, Arunachal Pradesh, Meghalaya, Tamil Nadu, Haryana)
Separate entry on details of sale to other licensees/ out of DISCOM area	8 SERCs & JERC (Jharkhand, Arunachal Pradesh, Meghalaya, Kerala, Tamil Nadu, Madhya Pradesh, Haryana, Rajasthan)

⁴ Refer to Annexures to see state specific MYT regulations.

⁵ Captive and BTM are not covered under sales forecasting regulations

Projection at monthly granularity	9 SERCs & JERC (Tripura, Arunachal Pradesh, Meghalaya, Haryana, Himachal Pradesh, J&K (MYT 2023), Telangana, Maharashtra, and Punjab)
Sales Projections Techniques suggested in MYT regulations	5 SERCs (West Bengal, Arunachal Pradesh, Meghalaya, Andhra Pradesh, Tamil Nadu)
Method for Unmetered Sales Estimation	7 SERCs (Bihar, Arunachal Pradesh, Meghalaya, Haryana, Chhattisgarh, Madhya Pradesh, Tripura)

This overview shows that many elements which typically influence future sales have been included in several state MYT regulations. However, many regulations lack the ability to provide details of methodology and data that should be used by discoms to arrive at the forecasts. For example, some commissions direct discoms to consider the impacts of factors such as seasonal and weather fluctuation, implementation of demand side management measures, energy efficiency and energy conservation policies, transmission and distribution loss reduction initiatives, open access (OA) transactions, social-economic and technological changes on sales. However, detailed data and methods to be used, to assess impact of these factors on sales estimation are not provided.

3. Sales Estimations Approach adopted by Discoms

Discoms are required to submit year-ahead sales projections for determination and approval of their annual revenue requirement (ARR) to respective Commissions. In this study, we reviewed the tariff petitions filed by discoms and tariff orders (issued by Commissions) to better understand details of the sales forecasting approach and methodology adopted by them. For the states of Andhra Pradesh and Telangana, we also reviewed the business plans and resource plans filed by discoms as they include granular data which has been used for demand estimation. This data has also been used to perform sales estimation analysis using different methods, presented later in this article.

As discussed in the previous section, MYT regulations recommend that the sales forecasting method should consider the impact of multiple factors that can potentially influence demand in the future. At the same time, it is also expected that granular data should be used by discoms to develop an accurate sales estimation. The overview of existing tariff petitions and orders shows that discoms are not able to adhere to all suggestions provided by such regulations. Table 2, below provides a summary of the methods adopted and factors considered by different discoms for sales forecasting through the review of ARR /Tariff Petitions and Business/Resource Adequacy Plans.

Table 2: Summary of the approach and methodology adopted by discoms for Sales Projections⁶.

Approach used for Sales Projections	No. of Discoms – Out of 62 DISCOMs considered for review	Remarks
Based on connected Volt-type	All Discoms	Connected Volt Category – LT, HT, EHT
Based on Consumer category/ subcategory and Tariff category/ subcategory	All Discoms	Domestic (BPL, Domestic Metered, etc.) Commercial, Agricultural, Industrial (SMEs, Steel Plant, Textile Industry, etc.), Power Looms, etc.
CAGR	42 Discoms	For all consumer and tariff categories/ subcategories
CAGR and Trend Analysis	5 Discoms (Tripura DL, MESCOM, TANGEDCO, Telangana State Discoms)	For all consumer and tariff categories/ subcategories
Other methods	<ul style="list-style-type: none"> • Linear Regression Method – APEPDCL (Andhra Pradesh Eastern Discom) • Monthly Linear Trend Method – APCPDCL (Andhra Pradesh Central Discom) • 2% nominal growth rate – BEST, TPC-D (Maharashtra) • Adjusted Trend Analysis Method – BRPL & BYPL (Delhi) 	For all consumer and tariff categories/ subcategories
Selected Growth rate	47 Discoms – category-wise selected growth rates are mentioned in their MYT petitions.	The rates are selected assuming realistic growth trajectories. In case of abnormal trends, nominal rates are assumed.
Time granularity used	Annual – 57 Discoms Monthly – 5 Discoms (Andhra Pradesh and Telangana)	9 SERC and JERC direct to estimate month-wise sales projections (Refer to Table 1)

This overview also shows that among different forecasting techniques, CAGR and trend analysis are used by approximately 75% of the discoms. Trend Analysis method is a non-causal forecasting technique assuming that the factors follow the same historical trend as past in future and focus on identifying the pattern and direction (increasing, decreasing or stable) of growth over time. Whereas, CAGR measures a smoothed annual growth rate while eliminating any

⁶ Refer to Annexure to see details of approach followed by Discoms

fluctuations of data assuming a steady growth for a specified time period longer than one year. The historical actual or audited sales, number of consumers, and connected load data are used to arrive at the CAGR. Although, the number of years used for determining the CAGR varies between 7 years to 3 years most common being 5 years, and some discoms also use annual or sub-annual data.

It is observed that in states such as Gujarat, Madhya Pradesh, and Uttar Pradesh all discoms use a uniform method for sales forecasting. However, in some other states like Andhra Pradesh, APEPDCL uses linear regression method for sales forecasting whereas APCPDCL uses monthly linear trend method and APSPDCL uses CAGR method for sales forecasting.

The Joint Electricity Regulatory Commission (JERC) and 9 other SERCs have also directed discoms to submit month-wise sales projections. But our analysis shows that only discoms of Andhra Pradesh and Telangana include category-wise monthly sales projections in their tariff petitions. Another interesting observation from the Department of Power, Arunachal Pradesh mentioned⁷, *“As seen from the category-wise monthly sale for the FY 2022-23 there is no effect on seasonal change, hence annual basis forecast has been adapted instead of a monthly basis.”*

4. Good practices included in regulations and adopted by discoms

In the previous section, we observed that most discoms adopt a consumer category-wise CAGR method for estimating future sales. These numbers may not necessarily be representative of the variations in consumption at circle or division level across consumer categories, for example, Some circles may observe higher growth in demand in comparison to discom-wide CAGR for particular consumer categories. This information will be helpful for more accurate power purchase planning and distribution network expansion. Some discoms have incorporated more granular approach in their sales estimation and data collection practices. Table 3 presents a brief overview of good practices adopted by discoms and included in regulations.

Table 3: Summary of good practices adopted in sales projections methods by SERC and discoms.

Particulars	Suggested By	Adopted By
Develop a robust consumer demand database	MYT regulations of Odisha (2022) ⁸ , Arunachal Pradesh (2018) ⁹ and Meghalaya (2014) ¹⁰	TPWODL (Western DISCOM of Odisha) did data sanitisation to eliminate ghost consumers. Other Discoms of Odisha, Jharkhand, Arunachal Pradesh and Meghalaya have not adopted yet.
Sales Forecast based on Load duration curve	Odisha MYT regulations, 2022	Not yet adopted by state Discoms
Circle-level sales projections	APEREC Guidelines on Load Forecasts, Resource Plans	Andhra Pradesh Discoms

⁷ [Dept. of Power, Arunachal Pradesh – MYT Petition & ARR for FY 2024-25 to 2026-27](#)

⁸ [OERC, MYT Regulations, 2022](#) (pp 54-55)

⁹ [APSERC, MYT Regulations, 2018](#) (pp 53)

¹⁰ [MSERC, MYT Regulations, 2014](#) (pp 87)

	and Power Procurement Plan for 4 th (FY2019-20 to FY2023-24) and 5 th ((FY2024-25 to FY2028-29) Control Period (2019) ¹¹	
Rural-urban area-wise sales projections	Not suggested in MYT regulations	Madhya Pradesh Discoms ¹²

It is interesting to observe that 3 state regulations have directed discoms to develop robust database of consumer demand to aid better future demand estimation. MYT regulation by Odisha Electricity Regulatory Commission (OERC) is the only regulation which suggests discoms to use load duration curve for sales forecasting.

Another interesting practice by Andhra Pradesh discoms, especially Central discom (APCPDCL) is that they have included consumer categories, such as Township, Religious places, Showrooms, etc. within HT category. They include category-wise monthly projections for each of these categories in sales estimation. The industrial sales during peak and off-peak time-of-day are also estimated for future by APCPDCL.

5. Recent Changes in Regulations

The states of Gujarat and Maharashtra have issued new draft MYT regulations in 2023 and 2024. Also, Karnataka ERC has recently notified new MYT regulations on 24th June 2024. A review of these regulations has been captured in the table below. These regulations are the first to emphasise the need for long-term and short-term demand estimation, using granular data sets for all consumer categories. They also recommend discoms to utilise advanced estimation techniques for sales forecasting.

Table 4: Review of draft MYT Regulations for Gujarat, Maharashtra and Karnataka.

SERCs	Changes introduced through new MYT Regulations
GERC	<p>Draft MYT Regulations, 2023</p> <p><i>Regulation 107</i></p> <p><i>107.1 "Distribution Licensee shall make an assessment of demand (MW) during peak and off-peak period and energy requirement (MU) for each month of the ensuing year (Short-term) and for next 5 (five) years (Long-term)."</i></p> <p><i>107.2 "Distribution Licensee shall submit a forecast of the expected sales of electricity</i> <i>Provided that while estimating should carry out for at least three scenarios – Optimistic scenario, Business As Usual (BAU) scenario & Pessimistic scenario,"</i></p>

¹¹ [APERC Guidelines on Load Forecasts, Resource Plans and Power Procurement Plan for 4th \(FY2019-20 to FY2023-24\) and 5th \(\(FY2024-25 to FY2028-29\) Control Period \(2019\)](#)

¹² Rural areas are notified by the GoMP vide notification no. 2010/F13/05/13/2006, whereas rest all other areas are considered as Urban.

	<p><i>107.3 "The sales forecast shall be based on methods and tools including load research studies, advance statistical methods including multivariate regression analysis, partial end use method (PEUM), econometric methods, and also explore use of various IT applications, including Artificial Intelligence and Machine Learning (AI/ML) to improve accuracy."</i></p> <p><i>107.4 ".... The Distribution Licensee(s) shall develop a robust database of all consumers with desired particulars regarding their demand to facilitate the forecasting process Provided that in the second year Distribution Licensee shall also submit a detailed load research study, based on consumer, feeder and DT meter data as well as survey information on appliance usage etc., with consumer category wise load curves, "</i></p>
MERC	<p>Draft MYT Regulations, 2024</p> <p><i>Regulation 100.2 (Sales Forecast) – "The sales forecast shall be consistent with the load forecast prepared as part of the power procurement plan under Part C of these Regulations...."</i></p> <p><i>Under Part C, 18 (Power Procurement) (18.1) – "The Distribution Licensee shall undertake its power procurement in accordance with Maharashtra Electricity Regulatory Commission (Framework for Resource Adequacy) Regulations, 2024."</i></p>
KERC	<p>MYT Regulations, 2024</p> <p><i>Regulation 17</i></p> <p><i>(1) The Licensee shall submit a month-wise forecast of the expected sales of electricity</i></p> <p><i>(2) The sales forecast shall be consistent with the load forecast prepared as part of the power procurement plan under Regulation 19 of these Regulations Provided that OA transactions shall not form part of sales.</i></p>

These regulations suggest inclusion of better sales estimation practices like use of scenario-based analysis, inclusion of load forecasting studies, use of granular data and development of consumer database. But it needs to be seen if future tariff petitions of discoms in these states incorporate suggested methods for sales estimation.

6. CEA Guidelines

Early last year the Central Electricity Authority published guidelines for [medium- and long-term power demand forecast](#) (July 2023) for utilities in the Indian Power Sector. The guidelines are intended to provide direction to utilities in order to bring uniformity in the approach of demand forecasting. These guidelines recommend that the annual growth rate for each consumer category can be derived using two simple and statistically appropriate methods, namely 'least squares method (LSM)' and 'weighted average method (WA)'.

The least square method is a mathematical approach for regression analysis. It focuses on finding the best-fitted curve for a set of data points while minimising the sum of the squares of the differences between observed values and predicted values. In the weighted average

method, each value in the datasets is assigned a specific weight which is used to calculate the average growth rate. In this method, certain values are assumed more significant and reliable over others. In current sales forecasting practice, we observe that only APEPDCL uses the linear regression method which follows the rule of least square technique to estimate the sales estimation.

Although CEA has recommended the use of specific methods, namely LSM and WA, the review of existing sales forecasting practices conducted by this study shows that CAGR is the most common method adopted by discoms for arriving at annual growth rates. Hence, we performed a simple sales forecasting analysis using these three different methods based on historical sales data for two discoms of Telangana TGNPDCL and TGSPDCL. Figures 1 & 2 present the results of this analysis.

Figure 1: TGNPDCL Projections for 2018-19, 2023-24

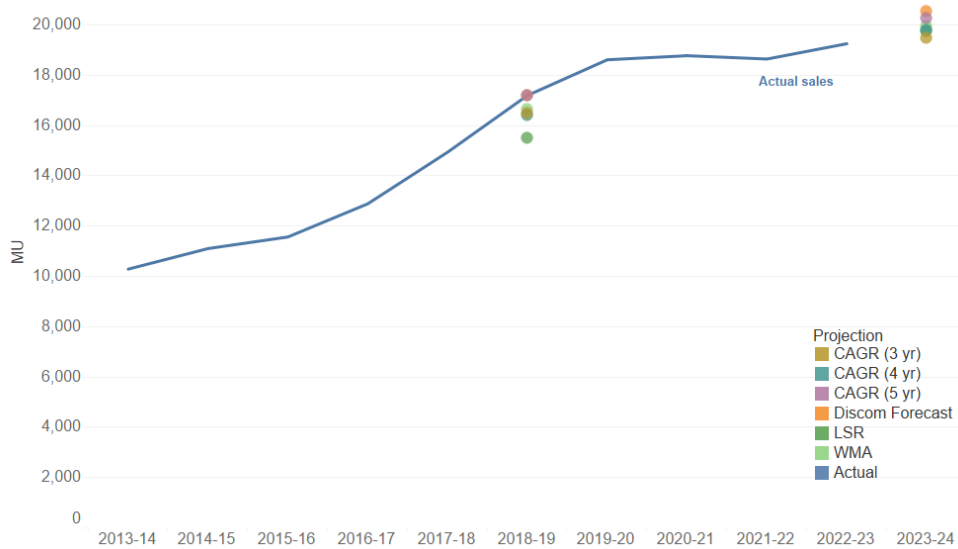
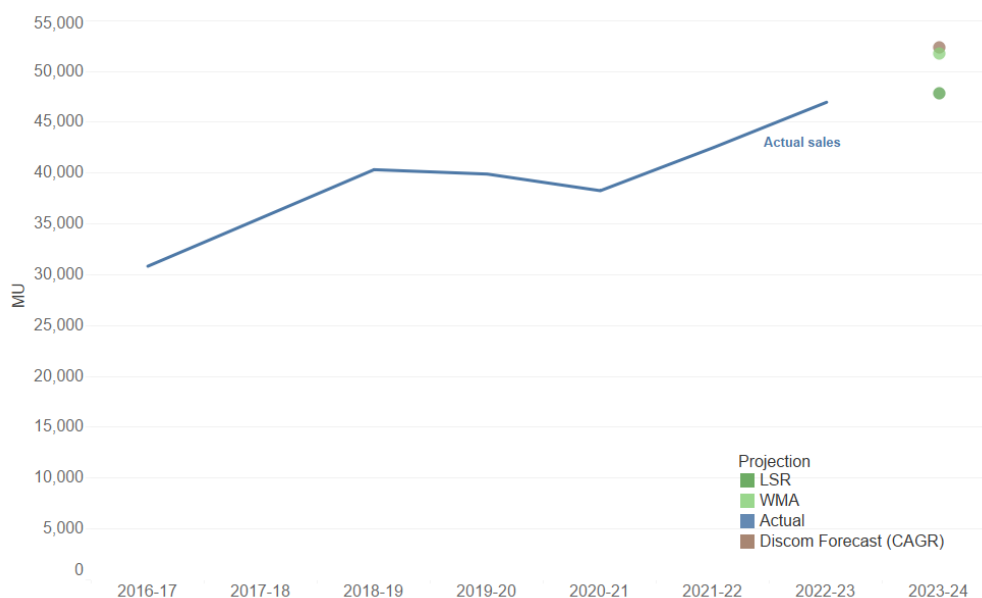


Figure 2: TGSPDCL Projection for 2023-24



We observe that for TGNPDCL, the projection for the year 2018-19 using the weighted average method was closer to actual sales for the year in comparison to CAGR and Least Square method. It needs to be seen whether the same will hold true for the projection in 2023-24 when actual sales data is published.

7. Conclusions and Way Forward

To conclude, this study finds that most discoms focus on sales estimation exercises in short and medium term for different consumer categories. But efforts on loss estimation which is also a contributing factor to total demand is conducted only at the discom level. CAGR is the most commonly used method for sales estimations across discoms. However, the spatial data and time granularity for estimations are low.

Some of the major challenges observed in current sales estimations approaches followed by discoms are:

1) Limited granularity in consumer types: Most discoms aggregate consumer types representing different consumption behaviours under single consumer category, and calculate average growth rate for all alike. For example, similar CAGR is used across all residential consumers whether rural, urban, living in high rise or slums potentially leading to over or underestimation of sales which can impact supply and service quality to consumers.

2) Clarity on assumptions and data values is lacking: No clear explanation or data is provided by discoms on assumptions used to arrive at annual growth rates. Such lack of clear information makes it difficult to also aggregate the sales projections at the country level.

3) Validation of historical sales projection absent: None of the regulatory processes seek to validate past sales projections. Such a process could potentially offer measures to introduce corrections in assumptions used for determination of growth rates for the future.

4) Variations in time granularity: Significant variations have been observed in historical time granularity used by discoms. This may have impacts on future estimations especially when demand variations owing to extreme weather changes are increasing and unforeseen events like COVID-19 alter demand patterns.

With increase in renewable (re) energy penetration in the grids, increase in newer electrical loads like EV and induction cookstoves and extreme climatic occurrences the demand for electricity needs to become more flexible. In this context, accurate prediction of demand becomes more important. Adoption of more granular and comprehensive methods of sales forecasting will hence become necessary. Several state Electricity Regulatory Commissions have also emphasized the need for discoms to use better demand estimation techniques through the incoming resource adequacy regulations. However, details on the granularity of data, categorization of consumers to capture spatial differences and objective evaluation of different techniques are missing.

The CEA and ERCs can provide a more detailed and uniform data collection frameworks for discoms to help increase the granularity of data in terms of consumer categories, spatial spread, time duration and list of factors that impact demand. This process can also help in evaluating best techniques for sales forecasting and also test the accuracy of historical projections. At the

same time discoms can support this process by collecting better feeder and distribution transformer level data in finer time blocks (15 minutes, hourly, daily), circle or division level consumer category-wise/connected load-wise sales data and provide detailed information on assumptions used for sales estimation. This will help in not just better demand projections but also load projections which are necessary for better power procurement and planning, and improving reliability of electricity infrastructure.




The authors thank their colleagues Sreekumar Nhalur and Aditya Chunekar for their valuable inputs and review of this document and Abhiram Sahasrabudhe for research support.

This article is part of an ongoing series called Power Perspectives which provides brief commentaries and analyses of important developments in the Indian power sector, in various states and at the national level.

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