

# REPORT ON TIME OF DAY (TOD) TARIFF FOR TANGEDCO

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## List of Abbreviations

APTEL	Appellate Tribunal for Electricity
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CGS	Central Generating Station
CY	Calendar Year
DPR	Detailed Project Report
DT	Distribution Transformer
DSM	Demand Side Management
EA, 2003	The Electricity Act, 2003
ERC	Electricity Regulatory Commission
FOR	Forum of Regulators
HT	High Tension
HVDS	High Voltage Distribution System
IT	Information Technology
kV	kilo-Volt
LT	Low Tension
MIS	Management Information System
MoU	Memorandum of Understanding
MU	Million Units
MYT	Multi Year Tariff
SERC	State Electricity Regulatory Commission
TNEB	Tamil Nadu Electricity Board
TANGEDCO	Tamil Nadu Generation and Distribution Corporation Limited
TANTRANSCO	Tamil Nadu Transmission Corporation Limited
TNERC	Tamil Nadu Electricity Regulatory Commission



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# 1 Background

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## 1.1 Overview of TANGEDCO

The erstwhile Tamil Nadu Electricity Board (TNEB) was a statutory body formed on July 01, 1957 under the Electricity (Supply) Act, 1948 as a successor to erstwhile Electricity Department of the Government of Madras. TNEB was a vertically integrated entity responsible for generation, transmission and distribution of electricity in the State of Tamil Nadu. The electricity network of TNEB was extended to all villages and towns throughout the State.

After the enactment of the EA, 2003, State Electricity Boards (SEB's) were mandated to re-organize under Section 131 of the EA, 2003. The Government of Tamil Nadu (GoTN) drew up a plan for restructuring the power sector for better implementation of the EA, 2003 and improve the financial performance of the power sector in the State of Tamil Nadu.

Accordingly, GoTN vide G.O. (Ms) No. 114 Energy Dept. dated October 08, 2008 accorded approval for re-organization of the erstwhile TNEB by establishment of a holding Company, namely TNEB Ltd., and two subsidiary companies, namely, Tamil Nadu Transmission Corporation Limited (TANTRANSCO) and Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) with the stipulation that the Companies shall be fully owned by the Government. TANGEDCO was incorporated on December 01, 2009 and was registered as a public limited Company and started functioning with effect from November 01, 2010.

TANGEDCO is primarily responsible for carrying out the functions of generation and distribution of electricity in the State of Tamil Nadu.

The total installed capacity of energy sources of TANGEDCO is 7,144.98 MW<sup>1</sup> as on 31.05.19, which includes Coal Thermal Capacity of 4,320 MW, Gas Thermal capacity

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<sup>1</sup> National Power Portal of India ([www.npp.gov.in](http://www.npp.gov.in))

of 524.08 MW, Hydro capacity of 2,178.20 MW, and Renewable Energy Sources capacity of 122.70 MW.

Since, TANGEDCO is also responsible for distribution of electricity, it has tied up power from different sources, to meet the balance energy requirements of the State. The capacity tied up<sup>2</sup> by TANGEDCO to meet its requirements is given below:

1. Central Generating Stations (CGS) – 6,037.50 MW
2. Independent Power Producers (IPPs) – 5,551.30 MW
3. Wind Capacity – 7,854.81 MW
4. Solar Capacity -1,702.40 MW
5. Biomass Capacity – 230 MW
6. Co-Generation Capacity – 692.40 MW

TANGEDCO serves around 2.88 Crore<sup>3</sup> consumers in the State of Tamil Nadu, as on 31.03.2019. TANGEDCO has significantly increased its distribution network over the years for effective utilization of energy. TANGEDCO has currently installed 2,93,301 Nos. of Distribution Transformers with a LT line network of 6.28 Lakh kilometres. The peak demand in the State has increased to 15,440 MW with per capita consumption of 1,389 units as on 31.03.2019.

As on 31.03.2019<sup>4</sup>, 63,956 Towns, Hamlets and Villages have been electrified. In addition to this, 18.02 Lakh Agriculture pump sets, and 10,55,705 huts have been given supply of electricity.

The State Electricity Regulatory Commissions (SERCs) have been vested with several critical roles as an independent regulator. The main functions spelt out in Section 86 of the EA, 2003 for the SERCs are-

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<sup>2</sup> Report on TANGEDCO's website

<sup>3</sup> Report on TANGEDCO's website

<sup>4</sup> Report on TANGEDCO's website



- (a) To determine the tariffs for generation, supply, transmission and wheeling of electricity whether bulk or retail within the State;
- (b) To regulate electricity purchase and procurement process of the Distribution Licensees including the price at which electricity would be procured;
- (c) To facilitate intra-State transmission and wheeling of electricity;
- (d) To issue Licence to Distribution Licensees, Traders and Transmission Licensees for intra-State operations;
- (e) To promote co-generation and generation from renewable sources of energy;
- (f) To adjudicate disputes involving Generating Companies and the Licensees and to refer disputes for arbitration;
- (g) To specify State Grid Code consistent with Grid Code specified by the CERC;
- (h) To specify standards of quality, continuity and reliability of service to be provided by Licensees;
- (i) To fix the trading margin in case of intra-State trading, if necessary;
- (j) To fix the fee and levy charges for the above functions in a transparent manner within the framework of National Electricity Policy, Plan and Tariff Policy;
- (k) To advise the State Government on restructuring of the sector and on promoting investment, competition, efficiency and economy in the sector and matters referred to by the Government.

## 1.2 Need of the Study

This study aims to understand the existing demand curve of TANGEDCO and improve the utilization of its generating stations and tied-up power sources, by flattening the load curve. TANGEDCO also desires to recover the cost of costly power purchase during peak hours through appropriate TOD tariff. The study shall also analyse whether the existing TOD tariff is suitably designed for full cost recovery.

The Time of Day (ToD) tariff is a widely accepted tool for effective Demand Side Management (DSM). ToD tariff comprises separate tariffs for peak hours and off-peak hours, in order to encourage reduction in the consumption during peak hours when the cost of power is very high, and increase in the consumption during off-peak hours when the cost of power is relatively lower.



Differential tariff for peak and off-peak provides for shifting of load from peak to off-peak hours or normal hours with a view to optimize generation capacity and minimize the cost of power procurement for the Distribution Licensee. ToD tariff also gains importance as measure to implement DSM and achieve energy efficiency.

The intention of ToD tariff is to levy additional charge on consumers for their consumption during peak hours and provide incentives/rebates in tariff for their consumption in off-peak hours, thereby helping to flatten the load curve. However, in case there is no shifting of demand from peak hours to off-peak/normal hours, ToD tariff enables the Distribution Licensee to recover the additional cost for supplying power to consumers during such peak hours.

The levy of ToD tariff is supported by the applicable legal, policy and regulatory framework present in the country. Section 62 (3) of the EA, 2003 allows the Commission to determine ToD tariff, as reproduced below:

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

The relevant provision of National Electricity Policy encouraging ToD Tariffs is reproduced below:

*“5.4.9 The Act requires all consumers to be metered within two years. The SERCs may obtain from the Distribution Licenses their metering plans, approve these, and monitor the same. The SERCs should encourage use of pre-paid meters. In the first instance, **TOD meters** for large consumers with a minimum load of one MVA are also to be encouraged. The SERCs should also put in place independent third-party meter testing arrangements”.*



The relevant provision of the Tariff Policy, 2016 in support of ToD Tariffs is reproduced below:

*“8.4 Definition of tariff components and their applicability*

*1. Two-part tariffs featuring separate fixed and variable charges and Time differentiated tariff shall be introduced on priority for large consumers (say, consumers with demand exceeding 1 MW) within one year. This would also help in flattening the peak and implementing various energy conservation measures.”*

The Forum of Regulators (FOR) has given the following recommendations in its Working Group Report on “Metering Issues”:

*“Time of the day metering is important while propagating and implementing Demand Side Management (DSM) and achieving energy efficiency. Hence, TOD metering and automatic meter reading system should be introduced wherever it has not already been done. High-end consumers with the connected load of 25kW and above should be covered under TOD metering.”*

The Hon’ble Appellate Tribunal for Electricity (APTEL), vide its Judgment in Appeal No. 257 of 2012 directed as under as regards TOD tariffs:

*“The aim of providing differential tariff for peak and off-peak hours is to shift load from peak to off-peak hours with a view to optimize the generation capacity and minimize the cost of power procurement for the distribution licensee. However, in the absence of a specific study on pricing of electricity for different time blocks the weighted average energy rate for peak, off-peak and normal hours (other than peak and off-peak) should be equal to the average energy rate decided for a particular category of consumer.”*

The Hon’ble APTEL directed to conduct a detailed study on the applicable ToD charges. In cognizance of the above APTEL directive, the Hon’ble Commission had directed TANGEDCO in its Tariff Order dated 20<sup>th</sup> June 2013, to furnish a detailed study on load pattern for retention of ToD charges, as reproduced below:

*“5.81 The Commission feels that a detailed study pertaining to load pattern needs to be done by TANGEDCO. Hence Commission pending a detailed study, proposes to retain the peak hour charges and off-peak rebate at the existing levels. Commission directs TANGEDCO in this order to carry out a detail study on this regard and furnish the same to the Commission. Accordingly, after reviewing the report furnished by TANGEDCO, Commission will address this issue in the next tariff order.”*

As part of its Multi-Year Tariff (MYT) Petition No. 1 of 2017, TANGEDCO submitted a Study Report on ToD consumption and the basis for levying peak hour charges, duly taking into account the load/demand curve, sourcing of power to meet load/demand and cost impact of this additional demand. Based on this Report, TANGEDCO justified the additional charges applicable to HT IA Industrial consumers during peak hours. The report submitted by TANGEDCO was based on the consumption details for FY 2013-14.

In the MYT Order dated August 11, 2017 for FY 2016-17 to FY 2018-19, the Commission determined ToD tariffs for FY 2017-18 based on the Load Generation Balance Report (LGBR) of FY 2015-16, since TANGEDCO had not submitted LGBR for FY 2016-17.

In the MYT Order dated August 11, 2017, the Commission has ruled as under:

*“5.13.12 TANGEDCO submitted the Load Generation Balance Report (LGBR) for FY 2015-16. The Commission notes that during FY 2015-16, the Restriction and Control (R&C) measures were implemented. Hence, the Commission sought the LGBR for FY 2016-17. However, TANGEDCO was unable to submit the LGBR for FY 2016-17. Hence, the Commission has carried out its analysis on the basis of LGBR for FY 2015-16, and approved the ToD tariffs for FY 2017-18, as detailed below.*

*5.13.13 In line with the directives of the Hon'ble APTEL to determine the differential pricing for peak hours and off-peak hours, the Commission has undertaken the study in two steps:*

(i) Determination of the peak hours and off-peak hours based on latest available load curve

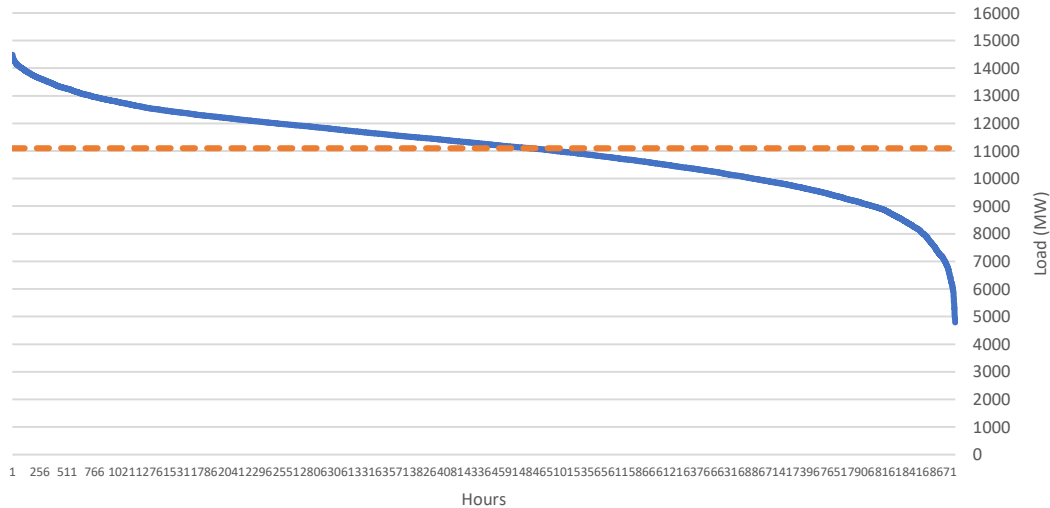
(ii) Determination of Differential price for peak and off-peak hours

5.13.14 A detailed analysis was conducted by the Commission on the demand met by the Licensee based on the details submitted by TANGEDCO. The hourly data for Demand, Load met, own generation sources utilised (including hydro power), wind power purchased, power purchased from CGS, power purchased from LTOA sources and MTOA sources, power purchased from CPPs, Biomass and Co-generation power plants and power purchased from Exchanges and UI were provided by the Licensee.

5.13.15 The Commission has considered the hourly data for every month of FY 2015-16 (8784 data points) and assessed the load met by the Licensee for every hour of the day for each month. The load curves were then plotted based on the demand met by the Licensee for every one-hour interval. A load curve was also plotted for analysis of how the load curve varied throughout the 24-hour window over the year.

5.13.16 The Commission has observed the daily variation and seasonal variation in the demand met by the Licensee. From the hourly data for each month, it is observed that Maximum Demand for FY 2015-16 was 14,484 MW, which occurred on March 17, 2016 at 1900 hours and March 28, 2016 at 1900 hours. However, Minimum Demand of 4,791 MW was recorded on November 10, 2015 at 0400 hours. At the outset, it is noted that the difference between Maximum Demand and Minimum Demand is very large. However, this difference is the result of the daily variation and seasonal variation. Such Maximum Demand and Minimum Demand has been recorded for a very small duration, as can be seen from the Load Duration Curve of TANGEDCO for FY 2015-16, as shown in the following Figure:

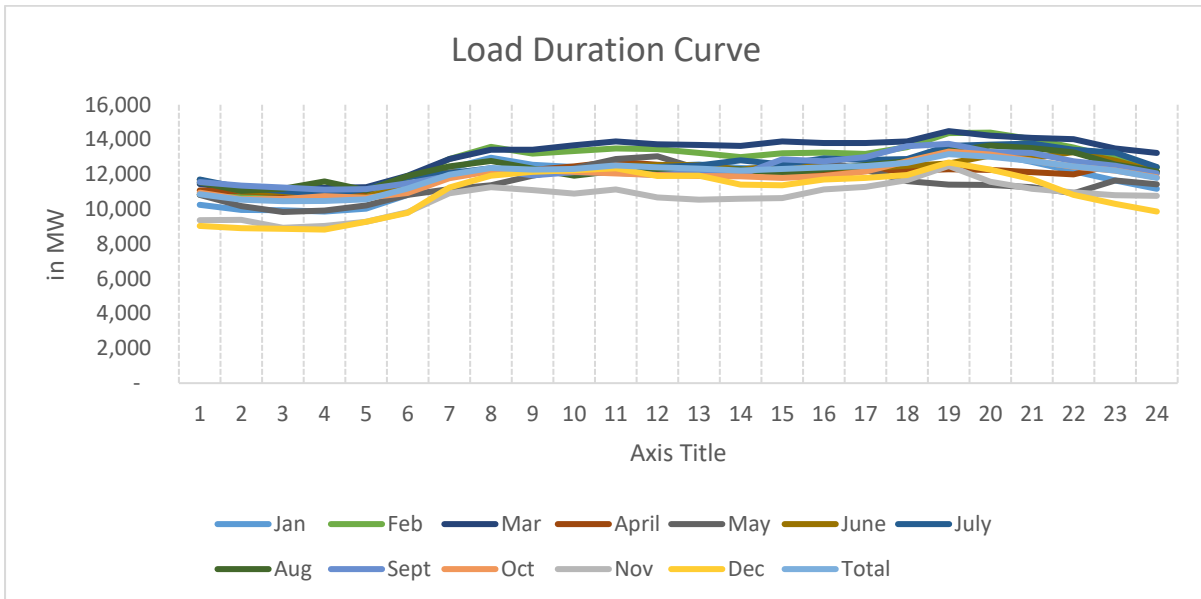
Annual Load Duration Curve



5.13.17 From the yearly Load Duration Curve, it is observed that:

- (i) The Maximum Demand for FY 2015-16 was 14,484 MW.
- (ii) Average demand for the year is 11,094 MW, which was recorded for 55.02% of time.
- (iii) The variation in Maximum Demand is 3,390 MW (14,484 – 11,094 MW) and variation in Minimum Demand is 6,303 MW (11,094 – 4,791 MW).
- (iv) There is sudden decrease in the demand for shorter period of time at the lower end of curve. These data points need to be considered as outliers.
- (v) The Base Load for the Distribution Licensee has been derived by excluding the outliers and considering the equal spread from the average demand for the year. The Base Load has been computed as 7,700 MW, which was recorded for 97% of the time.

5.13.18 For assessing the peak hours and off-peak hours, the Commission has considered the daily load curve of the particular day of the month on which the Maximum Demand in that month has occurred. The Peak hours and off-peak hours for each month have been derived by study of the representative monthly load curves as shown in the Figure below:



5.13.19 From the above figure, the peak hours, off-peak hours, and normal hours can be observed as under:

- (a) Morning Peak hours - 0600 hours to 0900 hours
- (b) Evening Peak hours - 1800 hours to 2100 hours
- (c) Off-peak hours - 2200 hours to 0500 hours
- (d) Normal hours - 0500 to 0600 hours, 2100 to 2200 hours, and 0900 hours to 1800 hours

5.13.20 It is seen that the above time-slots are same as the prevailing time-slots for peak, off-peak and normal hours. In view of the above, the Commission has retained the above time slots for the applicability of the peak hour charges/ToD tariff.

5.13.21 The Commission notes that TANGEDCO has contracted power with various sources to meet its load. However, some of the sources are used to meet its Base load and rest of the sources for meeting peak load. The actual LGBR, power purchase quantum and cost is available for FY 2015-16. The month-wise Base Load has been computed for FY 2015-16, based on which, the Commission has computed the quantum of energy required and differential price for meeting the load over and above the Base Load.

5.13.22 The Commission has considered the Base Load as 7700 MW for FY 2015-16. Based on month-wise Base Load, the Commission has computed the quantum of energy required and differential price for meeting the load over and above the Base Load as under:

- (a) The hourly (8784 data points) contracted power has been considered including the power from TANGEDCO's own generating stations, Central Generating Stations, IPPs, CPPs, Biomass and Co-generation plants.
- (b) The power available from these sources after meeting the Base Load for the particular month has been considered against the quantum of power required over and above the Base Load.
- (c) Accordingly, the total round the clock Peak energy requirement has been computed for 8784 data points as 20,590.95 MU for FY 2015-16. Out of this, the peak energy requirement of 2,304 MU is pertaining towards Peak period defined under Time of Day framework.
- (d) For meeting this energy, the sources of power have been considered from the highest rank in the Merit Order stack in descending order, as approved by the Commission for FY 2015-16 after Truing up
- (e) The energy requirement of 2,304 MU has met by sources as shown in the following Table:

**Table 5-34: Computation of Differential price for FY 2015-16**

Sr. No.	Source of Power	Energy purchased (MU)	Energy purchased towards Peak period (MU)	Energy Charges (Rs. /kWh)
1	Trading – Bilateral and Exchange	14,184	2,304	5.14
2	<b>Total</b>	<b>14,184</b>	<b>2,304</b>	<b>5.14</b>

- (f) The weighted average rate of power purchase for meeting peak period energy has thus been computed as **Rs. 5.14/kWh** for FY 2015-16. The average power purchase cost computed for FY 2015-16 as Rs. 4.22/kWh. The weighted



average energy charges computed for FY 2015-16 as **Rs. 3.18/kWh**. Hence, the price for procurement of additional energy for peak period is definitely higher than 20% of the weighted average energy charges for FY 2015-16. Hence, the Commission has decided to continue the same level of extra charges for peak hour consumption.

5.13.23 The break-up of the hours into peak period, off-peak period, and normal period is as under:

- (a) Morning Peak hours - 0600 hours to 0900 hours
- (b) Evening Peak hours – 1800 hours to 2100 hours
- (c) Off-peak hours – 2200 hours to 0500 hours
- (d) Normal hours – 0500 to 0600 hours, 2100 to 2200 hours, and 0900 hours to 1800 hours

5.13.24 Thus, the Commission approves levy of extra charge of 20% on energy charges for power consumption during peak hours from 0600 hours to 0900 hours and 1800 hrs to 2100 hrs, and a rebate of 5% on energy charges for power consumption during off-peak hours from 2200 hrs to 0500 hrs for HT IA category consumers.

5.13.25 Further, the Tariff Policy stipulates that ToD tariffs should be eventually introduced for all consumers including Residential category consuming above identified consumption levels. However, at present, the available data is not sufficient to even modify the existing ToD dispensation, which is applicable for HT IA Industrial category. TANGEDCO is directed to undertake a detailed study of hourly consumption patterns of HT IA category as well as other HT consumer categories, based on ABT metering data, to identify which category is contributing how much to the peak consumption, which category can shift its consumption to off-peak hours, seasonal variation in the peak and off-peak consumption levels. Based on this study, TANGEDCO should submit a comprehensive proposal to modify/upgrade the ToD tariff dispensation, along with its next Tariff Petition. While

*doing so, TANGEDCO should bear in mind that the objective of the ToD tariff is to facilitate and encourage shift of consumption from peak to off-peak hours, as well as to recover the additional power purchase cost incurred during peak hours.”(emphasis added)*

The Commission vide MYT Order dated August 11, 2017 directed TANGEDCO to conduct a study on ToD tariff. The relevant extract of the specific Directive is reproduced below:

*“k) ToD Charges are to be progressively implemented in order to flatten the load curve and to ensure the cost of energy paid by the consumer at any point of time reflects the true cost of supply available at that point of time. TANGEDCO is directed to:*

- i. Undertake a detailed study of hourly consumption patterns of all HT consumer categories, based on ABT metering data*
- ii. Identify the contribution of each category towards the peak consumption and which category can shift its consumption to off-peak hours, seasonal variation in the peak and off-peak consumption levels.*
- iii. Submit a comprehensive proposal to modify/upgrade the ToD tariff, along with its next Tariff Petition”.*

Thus, the Commission directed TANGEDCO to submit a comprehensive proposal to modify/upgrade the ToD tariff dispensation, along with its next Tariff Petition. The Commission has stated that TANGEDCO should bear in mind that the objective of the ToD tariff is to facilitate and encourage shift of consumption from peak to off-peak hours, as well as to recover the additional power purchase cost incurred during peak hours.

In order to comply with the above directive, TANGEDCO floated a limited Tender vide Specification No. DSM – 01 /2018-19 for conducting ToD study of TANGEDCO, as detailed below.

### **1.3 Scope of Work**

The Scope of Work for the present Study is given below:

*“To conduct a detailed study on the existing ToD tariff in respect of HT service connections in TANGEDCO in accordance with the following directions of TNERC to TANGEDCO:*

- i. Undertake a detailed study of hourly consumption patterns of all HT consumer categories, based on ABT metering data*
- ii. Identify the contribution of each category towards the peak consumption and which category can shift its consumption to off-peak hours, seasonal variation in the peak and off-peak consumption levels.*
- iii. Submit a comprehensive proposal to modify/upgrade the ToD tariff, along with its next Tariff Petition.*

The tender specifies the detailed Terms of Reference of the Study as under:

- 1. “Detailed study of hourly consumption patterns of HT IA (industrial service connections) and III (commercial service connections) categories as well as other HT consumer categories, based on ABT metering data.*
- 2. Assessment of contribution of different categories to the peak consumption, identification of category that can shift its consumption to off-peak hours and seasonal variation in the peak and off-peak consumption levels.*
- 3. Analysis of data and recommendations in terms of*
  - a. categories to whom the ToD tariff can be extended to.*
  - b. time line for extension of ToD tariffs, i.e., 1 year, 2 years, phased manner, etc.*
  - c. fixing of peak load hours, off-peak load hours and normal load hours during the day by studying contribution to meet load curve.*
  - d. Study of seasonal changes during the year in terms of peak load hours, off-peak load hours, and normal load hours during the day for generation and sales data.*
  - e. Justification for existing ToD tariff peak hour surcharge.*
  - f. ToD tariff in terms of additional charges to be levied during peak hours and rebates to be offered during off-peak hours during different seasons for ensuing periods.*
- 4. Preparation of draft report on the subject study and submission to TANGEDCO.*
- 5. Discussion on the draft report with TANGEDCO at Chennai and subsequent modifications, if any.*
- 6. Submission of final report (both hard and soft copies) to TANGEDCO.*

7. Power Point Presentation on the final report at TANGEDCO headquarters.
8. Presentation before the Hon'ble Tamil Nadu Electricity Regulatory Commission.
9. Furnishing data gaps after submission of reports to Hon'ble TNERC and to support till final approval from Hon'ble TNERC and appeal if any.
10. The documents furnished by TANGEDCO shall be handed over back to TANGEDCO on completion of the contract."

## 1.4 Appointment of Consultant

On successful completion of the tender process, TANGEDCO appointed M/s ABPS Infrastructure Advisory Pvt. Ltd. (ABPS Infra), for undertaking the present study.

## 1.5 Approach and Methodology of Study

In order to meet the requirement of the above Terms of Reference, ABPS Infra in consultation with TANGEDCO, has adopted the following Task-wise approach for completion of the assignment:



### Methodology for determination of ToD Tariff

- Task 1 - Demand side Analysis
- Task 2- Supply side Analysis
- Task 3 - Seasonal Analysis
- Task 4 - Proposed ToD slots and Tariff

### Task 1 - Demand Side Analysis

The analysis of the load profile of the State is important to ascertain the time of occurrences of peak in the grid and to analyse the possibilities of shift in the load profile of the consumers. ABPS Infra has analysed the hourly demand data for the last two years for concluding on how the demand curve is trending. The analysis has also been used to assess the peak, off-peak and normal hours of the State during the year.



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## **Task 2 – Supply Side analysis**

Supply side analysis has been undertaken to ascertain the sources being utilised to meet the peak demand and the cost of procurement of power from such sources. This has been used to establish a co-relation between the rate at which peak power is procured and the rate of ToD tariff that is made applicable to selected consumer categories who are drawing the power during peak hours.

## **Task 3 – Seasonality Analysis**

Seasonality analysis has been done to check whether the peak and off-peak hours are changing with the changes in weather conditions and climate that occur during the course of the year. Differential ToD Tariff can be implemented, based on such seasonality analysis.

## **Task 4 – Proposed ToD Slots and Tariff**

Based on the above analysis, ABPS Infra has verified whether the existing ToD slots are appropriate and if not appropriate, has proposed different time slots for peak, off-peak and normal hours. ABPS Infra has also proposed differential ToD tariffs for peak and off-peak hours, in order to achieve the stated objectives.

## **1.6 Structure of this Report**

The present Report is divided into the following Chapters -

**Chapter 1 – Background –** (present Chapter)

**Chapter 2 – Present ToD framework and Data Collection-** This Chapter includes the existing framework of ToD tariff and what all data considered for analysis of ToD tariff.

**Chapter 3 – Demand Analysis –** This Chapter discusses the analysis of category-wise hourly and seasonal demand.



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**Chapter 4 - Meeting Demand Supply Gap** - This Chapter discusses the analysis of source-wise Supply, especially for meeting the demand during peak hours, and the cost of such power purchase vis-à-vis the revenue from ToD tariff.

**Chapter 5 - Recommendations and Conclusions** - This Chapter details the final conclusions and recommendations arising out of this Study.

## 2 Present ToD framework and Data Collection

### 2.1 Present Time of Day Tariff Framework

The Commission vide Tariff Order dated August 11, 2017 had approved ToD charges for HT 1A category of consumers. The relevant extract is as follows.

*“5.13.24 Thus, the Commission approves levy of extra charge of 20% on energy charges for power consumption during peak hours from 0600 hours to 0900 hours and 1800 hrs to 2100 hrs, and a rebate of 5% on energy charges for power consumption during off-peak hours from 2200 hrs to 0500 hrs for HT IA category consumers...”*

As seen from the above extract, the ToD tariffs are presently applicable for HT 1A Industrial establishments only, and the additional charges are 20% of the energy charges for morning peak and evening peak and a rebate of 5% for off-peak hour consumption.

Accordingly, the present Tariff applicable for HT 1A category including Time of Day Tariff, is shown in the following Table:

Table 1: Present Applicable Time of Day Tariff for HT 1A Category

Sr. No.	Time Slot	Energy Charges (paise/kWh)	Demand Charges (Rs./kVA/month)
1	0600 to 0900 Hours	762	350
2	0900 to 1800 Hours	635	350
3	1800 to 2100 Hours	762	350
4	2100 to 2200 Hours	635	350
5	2200 to 0500 Hours	603	350
6	0500 to 0600 Hours	635	350

For other consumer categories apart from HT 1A, time differential tariff is not applicable, and energy charges are constant throughout the day. This has two-way implications, i.e., consumers from other categories do not have to pay additional



charges for peak hours but at the same time, they do not have the incentive to shift their consumption to night hours.

## 2.2 Approach adopted by TNERC in previous Tariff Orders

The Commission introduced ToD tariffs for HT 1A category consumers vide Tariff Order dated April 01, 2012. Since then, ToD tariff has been made applicable @ 20% of energy charges during peak period and 5% rebate during off-peak period. The relevant extracts of the Tariff Order dated April 01, 2012 are as follows:

*“10.2.5 The HT Industrial consumers (HT IA) shall be billed at 20% extra on the energy charges for the energy recorded during peak hours. The duration of peak hours shall be 6.00 A.M to 9.00 A.M and 6.00 P.M to 9.00 P.M.*

*10.2.6 The HT Industrial Consumers (HT I A) shall be allowed a reduction of 5% on the energy charges for the consumption during 10.00 P.M to 5.00 A.M as an incentive for night consumption.”*

There were several objections on the ToD charges levied on HT 1A Industrial consumers. The Commission vide Tariff Order dated April 01, 2012 directed TANGEDCO to submit data on ToD consumption, as reproduced below:

*“The TANGEDCO is directed to submit data on ToD consumption along with the subsequent Tariff Application for all consumers where ToD meters have been installed.”*

The Commission, in the Tariff Order dated June 20, 2013, quoted the relevant extract of the APTEL Judgment in Appeal No. 257 of 2012. The Commission concluded that a detailed study pertaining to load pattern needs to be done by TANGEDCO. The Commission, pending a detailed study, retained the peak hour charges and off-peak charge rebate at existing levels.

The Commission, in the Tariff Order dated December 12, 2014, stated that during the peak hours, marginal cost of power procurement is higher and being a revenue neutral regulated business, a pass-through mechanism has to be made available to the Utility to recover its cost and also to disincentivise the avoidable consumption during the peak period.

TANGEDCO, in line with the direction given in the Tariff Order dated June 20, 2013, submitted a preliminary study report assessing the cost of power purchase during various time slots during the day for FY 2013-14 with the aim of determining the variations in power purchase cost during such time intervals and with the imposition of Restriction and Control (R&C) on consumers. Since the report was not assessed by the Commission till the issuance of Tariff Order, the Commission continued the ToD Tariff to HT 1A Industrial consumers.

The relevant extract on ToD Tariff in the Tariff Order dated December 12, 2014 is as follows:

*“2.532 With regards to peak hour charge of 20% of energy charge, the Commission opines that during the Peak hours, marginal cost of power procurement is higher and being a revenue neutral regulated business, a pass-through mechanism has to be made available to the Utility to recover its cost and also to disincentivise the avoidable consumption during the peak period. Further TANGEDCO in line with the direction given by the Commission in its last tariff order, has submitted a preliminary study report assessing the cost of power purchase during various time slabs during the day, for the year 2013-14 with the aim of determining any variations in power purchase cost during such time intervals and with the imposition of R&C on consumers. The Commission pending the scrutiny of this report will continue with the present peak and off-peak charges.*

*2.533 As per APTEL’s Order it will be incorporated in FY2015-16 Order after taking a decision on the stand taken by TANGEDCO.”*

The Commission issued the MYT Order on August 11, 2017. In this Order, the Commission arrived at the conclusion that since the cost of power purchase for peak hours is higher by more than 20% of the average power purchase cost, the levy of 20% on energy charges for peak-hours is justified. The Commission hence, continued to levy the ToD tariff for HT 1A consumers based on the above conclusion i.e., levy of extra charge of 20% on energy charges for power consumption during peak hours from 0600 hours to 0900 hours and 1800 hours to 2100 hours, and a rebate of 5% on

energy charges for power consumption during off-peak hours from 2200 hours to 0500 hours.

Further, the Commission also directed TANGEDCO to take up a detailed study in this regard. The relevant extract of the Order is as under:

*“Further, the Tariff Policy stipulates that ToD tariffs should be eventually introduced for all consumers including Residential category consuming above identified consumption levels. However, at present, the available data is not sufficient to even modify the existing ToD dispensation, which is applicable for HT IA Industrial category. TANGEDCO is directed to undertake a detailed study of hourly consumption patterns of HT IA category as well as other HT consumer categories, based on ABT metering data, to identify which category is contributing how much to the peak consumption, which category can shift its consumption to off-peak hours, seasonal variation in the peak and off-peak consumption levels. Based on this study, TANGEDCO should submit a comprehensive proposal to modify/upgrade the ToD tariff dispensation, along with its next Tariff Petition. While doing so, TANGEDCO should bear in mind that the objective of the ToD tariff is to facilitate and encourage shift of consumption from peak to off-peak hours, as well as to recover the additional power purchase cost incurred during peak hours.”*

The Commission has emphasized on objectives of TOD tariff, i.e., to facilitate and encourage shift of consumption from peak to off-peak hours and to recover the additional power purchase cost incurred during peak hours. While conducting this study, these objectives have also been kept in mind and accordingly data collection and analysis has been done.

### **2.3 Review of Time of Day Tariff Framework in Other States**

ABPS has compared the applicable ToD tariff across major States. It is observed that majority of the States have ToD tariff in place and in some of the States, the ToD tariff has been differentiated across seasons. This section details out the variance in ToD tariff structure and tariff rates across key States.

**Maharashtra:** There are six (6) Distribution Licensees in Maharashtra and ToD tariff is applicable across quite a few categories at LT and HT level, including 2 small SEZ Distribution Licensees. The State Utility, MSEDCL, has different peak and off-peak rates as compared to other Distribution Licensees in Maharashtra. TPC-D, BEST and AEML-D on the other hand have the same peak and off-peak rates. The morning peak is from 09:00-12:00 hours, evening peak is from 18:00-22:00 hours and off-peak is from 22:00-06:00 hours, which is common across all Distribution Licensees in Maharashtra. Following are the Distribution Licensee-wise tariffs for peak and off-peak periods in Maharashtra.

*Table 2: Additional ToD tariffs in Maharashtra*

Consumer Categories	MSEDCL	AEML-D, TPC-D & BEST
HT - Industrial, Commercial, PWW, Govt, Education and Hospitals, Public Services, Electrical Vehicles	09:00-12:00 hours – Rs. 0.80 per unit 18:00-22:00 hours – Rs. 1.10 per unit 22:00-06:00 hours – Rs. 1.50 per unit rebate	09:00-12:00 hours – Rs. 0.50 per unit 18:00-22:00 hours – Rs. 1.00 per unit 22:00-06:00 hours – Rs. 0.75 per unit rebate
LT - Industrial, Commercial, PWW, Govt, Education and Hospitals, Public Services, Electrical Vehicles	09:00-12:00 hours – Rs. 0.80 per unit 18:00-22:00 hours – Rs. 1.10 per unit 22:00-06:00 hours – Rs. 1.50 per unit rebate	09:00-12:00 hours – Rs. 0.50 per unit 18:00-22:00 hours – Rs. 1.0 per unit 22:00-06:00 hours – Rs. 0.75 per unit rebate

**Gujarat:** There are 8 Distribution Licensees in Gujarat including State Utilities and private Utilities, which have ToD tariff in place. ToD tariff is applicable for most of the HT categories and some of the LT categories. All the Utilities have different tariffs for different peak and off-peak periods. The State Utilities namely MGVCL, PGVCL, UGVCL and DGVCL have common rates for ToD tariff. TPL-D Ahmedabad has different time blocks in different seasons for peak and off-peak period as compared to the rest of the State and other private Utilities. Some of the Distribution Licensees also have a separate category defined **exclusively for night usage** from 22:00-06:00 hours, where the concession from normal tariff is around ~ Rs.2.00 - Rs.4.00 per unit. Following are the Distribution Licensee-wise rates for peak and off-peak periods in Gujarat:

Table 3: Additional ToD rates in Gujarat

Consumer Categories	UGVCL, MGVCL, PGVCL, DGVCL, ASPEN	TPL-D (Ahmedabad)	TPL-D (Surat) and Dahej
HT Industrial, Commercial, PWW, Temporary and Metro Traction	07:00-11:00 hours - Rs. 0.45 - 0.85 per unit 18:00-22:00 hours - Rs. 0.45 - 0.85 per unit No rebate during off-peak period	<b>April to October</b> 12:00-17:00 hours & 18:30 -21:30 hours - Rs. 0.80 - 1.00 per unit for Industrial and Rs. 0.60 per unit for rest of HT Categories <b>November to March</b> 08:00-12:00 hours & 18:00 -22:00 hours - Rs. 0.80 - 1.00 per unit and Rs. 0.60 per unit for rest of HT Categories Night Rebate from 22:00-06:00 hours - Rs. (0.30) per unit for all months	TPL-D Industrial & 18:00-22:00 hours - Rs. 0.65 - 1.00 per unit 22:00-06:00 hours - Rs. 0.30 per unit rebate Other HT Category 07:00-11:00 hours & 18:00-22:00 hours - Rs. 0.45 - 0.80 per unit 22:00-06:00 hours - Rs. 0.30 per unit rebate Dahej 07:00-11:00 hours & 18:00-22:00 hours - Rs. 0.35 - 0.75 per unit Separate Category exclusively for night consumption from 22:00-06:00 hours
LT Industrial, Commercial, PWW	Separate category for Industrial and Commercial use exclusively for night consumption PWW Rebate: 11:00-18:00 hours - Rs. (0.45) per unit 22:00-07:00 hours -Rs. (0.85) per unit	ToD Tariff not applicable for LT Category	ToD Tariff not applicable for LT Category for TPL-D Separate category in Dahej for Industrial and Commercial exclusively for night use.

**Andhra Pradesh:** There are 2 Distribution Companies in Andhra Pradesh and both have ToD tariffs in place. ToD tariff is applicable across major categories of HT. ToD tariffs are not applicable for LT Categories. Separate peak periods for morning and

evening are defined, while off-peak is during night hours. Following are the ToD tariffs in the State of Andhra Pradesh:

*Table 4: Additional ToD rates in AP*

Consumer Categories	APSPDCL	APEPDCL
HT Industrial, Commercial, Public Services,	<p><b>Industrial</b> 06:00-10:00 hours – Rs. 1.0 per unit 18:00-22:00 hours – Rs. 1.0 per unit 22:00-06:00 hours – Rs. 1.0 per unit rebate</p> <p><b>Others</b> 18:00-22:00 hours – Rs. 1.0 per unit</p>	<p><b>Industrial</b> 06:00-10:00 hours – Rs. 1.0 per unit 18:00-22:00 hours – Rs. 1.0 per unit 22:00-06:00 hours – Rs. 1.0 per unit rebate</p> <p><b>Others</b> 18:00-22:00 hours – Rs. 1.0 per unit</p>

**Karnataka:** There are five (5) Distribution Companies in Karnataka and ToD tariff is applicable for LT Industrial category and most of the HT categories viz. HT Water Supply and Sewage, HT Industrial, HT Commercial, and HT Government Hospitals & Education Institutions. The time slot for morning peak, evening peak and off-peak hours is the same across all Distribution Companies in Karnataka. The morning peak is from 06:00-10:00 hours, evening peak is from 18:00-22:00 hours, and off-peak is from 22:00-06:00 hours. All the DISCOMs have same additional charge for morning peak hours and evening peak hours and; a similar rebate during off-peak hours. The following are the DISCOM-wise rates for peak and off-peak hours in Karnataka:

*Table 5: Additional ToD rates in Karnataka*

Consumer Categories	BESCOM, HESCOM, MESCOM, GESCOM, CESC
LT Industry, HT Industry, HT Commercial and HT Government Hospitals & Education Institutions	06:00-10:00 hours – Rs. 1.0 per unit 18:00-22:00 hours – Rs. 1.0 per unit 22:00-06:00 hours – Rs 1.0 per unit rebate

**Kerala:** The ToD tariff is applicable only for HT Industrial and LT Industrial Category. Only evening peak is considered to be a peak period in the State while off-peak is during night hours. The ToD tariff is approved as percentage of normal tariff. Following are the ToD tariffs in the State of Kerala:

Table 6: ToD rates in Kerala

Consumer Categories	KSEB
HT Industrial	18:00-22:00 hours – 1.5 times (150%) of normal tariff 22:00-06:00 hours – 0.75 times (75%) of normal tariff
LT Industrial above 20 KV	18:00-22:00 hours – 1.5 times (150%) of normal tariff 22:00-06:00 hours – 0.75 times (75%) of normal tariff

**Rajasthan:** Rajasthan has 3 Distribution Companies, which are State owned Utilities. However, currently there are no ToD tariff rates applicable in the State.

**Uttarakhand:** Uttarakhand has a single State Distribution Licensee, namely UPCL. The ToD rates in Uttarakhand are seasonal. There are 2 different seasons defined for Uttarakhand, i.e., April to September and October to March. Different ToD rates are applicable at different time slots during these seasons. ToD is applicable only for LT Industrial and HT Industrial Category. Following are the ToD tariffs in the State of Uttarakhand.

Table 7: Additional ToD rates in Uttarakhand

Consumer Categories	UPCL
HT Industrial	<b>April to September</b> 06:00-09:00 hours & 18:00-22:00 hours – Rs. 2.18 per unit 22:00-06:00 hours – Rs. 0.65 per unit rebate <b>October to March</b> 18:00-23:00 hours – Rs. 2.18 per unit 23:00-07:00 hours – Rs. 0.65 per unit rebate
LT Industrial	<b>April to September</b> 06:00-09:00 hours & 18:00-22:00 hours – Rs. 2.0 per unit 22:00-06:00 hours – Rs. 0.60 per unit rebate <b>October to March</b> 18:00-23:00 hours – Rs. 2.0 per unit 23:00-07:00 – Rs. 0.60 per unit rebate

**Uttar Pradesh:** Uttar Pradesh has 5 Distribution Companies in the State. The ToD rates in Uttar Pradesh are seasonal. There are 2 different seasons defined for Uttar Pradesh, i.e., April to September and October to March. Different ToD rates are applicable at different time slots during these seasons. ToD is applicable only for LT Industrial and



HT Industrial Category. ToD tariff is also additionally applicable for LT Street Lighting category as well. The ToD tariff is approved as percentage of normal tariff. Following are the ToD tariffs in the State of Uttar Pradesh:

*Table 8: ToD rates in Uttar Pradesh*

Consumer Categories	All Discoms
HT Industrial	<p><b>April to September</b>            05:00-11:00 hours – 0.85 times (85%) of normal tariff            17:00-23:00 hours – 1.15 times (115%) of normal tariff            No rebate for night consumption during this period</p> <p><b>October to March</b>            17:00-23:00 hours – 1.15 times (115%) of normal tariff            23:00-05:00 hours – 0.85 times (85%) of normal tariff</p>
LT Industrial	<p><b>April to September</b>            05:00-11:00 hours – 0.85 times (85%) of normal tariff            17:00-23:00 hours – 1.15 times (115%) of normal tariff            No rebate for night consumption during this period</p> <p><b>October to March</b>            17:00-23:00 hours – 1.15 times (115%) of normal tariff            23:00-05:00 hours – 0.85 times (85%) of normal tariff</p>
LT Street Light	05:00-11:00 hours – 1.20 times (120%) of normal tariff 11:00-17:00 hours – 1.20 times (120%) of normal tariff No rebate for night consumption during this period

**Punjab:** Punjab has 1 Distribution Licensee in the State. The ToD rates in Punjab are seasonal. There are 3 different seasons defined for Punjab, i.e., April to May, June to September, and October to March. Different ToD rates are applicable at different time slots during these seasons. ToD is applicable only for HT Industrial Category. Following are the ToD tariffs in the State of Punjab:

*Table 9: Additional ToD rates in Punjab*

Consumer Category	ToD Rates
HT Industrial	<p><b>April to May</b>            22:00-06:00 hours – Rs. 1.25 per unit rebate</p> <p><b>June to September</b>            18:00-22:00 hours – Rs. 2.0 per unit</p>

Consumer Category	ToD Rates
	<b>October to March</b> 22:00-06:00 hours – Rs. 1.25 per unit rebate

**Assam:** APDCL is the only Distribution Licensee in Assam and has ToD tariffs in place. The ToD tariff is applicable only for HT Industrial, HT Tea & Coffee and HT Oil & Coal. Only evening peak is considered to be a peak period in the State while off-peak is during night hours. Following are the ToD tariffs in the State of Assam:

*Table 10: Additional ToD rates in Assam*

Consumer Categories	ToD Rates
HT Industrial, HT Tea & Coffee, HT Oil & Coal	17:00-22:00 hours – Rs. 1.50 per unit 22:00-06:00 hours – Rs. 1.50 per unit rebate

**Chhattisgarh:** CSPDCL is the only Distribution Licensee in Chhattisgarh and has ToD tariffs in place. The ToD tariff is applicable only for HT Industrial, HT Mines, Coal and HT Steel. The peak period is considered from 22:00 hrs to 01:00 hours and charged additional tariff, with the early morning and morning hours considered as off-peak hours, and subjected to lower tariff. The ToD tariff is approved as percentage of normal tariff. Following are the ToD tariffs in the State of Chhattisgarh:

*Table 11: ToD rates in Chhattisgarh*

Consumer Categories	ToD Rates
HT Industrial, HT Mines, Coal and HT Steel	22:00-01:00 hours – 1.20 times (120%) of normal tariff 04:00-10:00 hours – 0.80 times (80%) of normal tariff

**Delhi:** There are four Distribution Licensees in Delhi with ToD tariffs in place. The ToD tariff is applicable for all LT and HT categories except Domestic category. Only evening peak is considered to be a peak period in the State while off-peak is during night hours. The ToD tariff is approved as percentage of normal tariff. It is to be noted that ToD tariff is applicable only for the months from May to September. Following are the ToD tariffs in the State of Delhi:

*Table 12: ToD rates in Delhi*

<b>Consumer Categories</b>	<b>ToD Rates</b>
All HT Categories except Domestic	22:00-01:00 hours - 1.20 times (120%) of normal tariff 04:00-10:00 hours - 0.80 times (80%) of normal tariff
All LT categories except Domestic	22:00-01:00 hours - 1.20 times (120%) of normal tariff 04:00-10:00 hours - 0.80 times (80%) of normal tariff

The following Table shows different parameters present in all the States discussed above with respect to ToD Tariff.

Table 13: Inter-State Comparison of State DISCOMs on ToD Tariff structure

Parameters	Maharashtra	Gujarat	Andhra Pradesh	Kerala	Karnataka	Rajasthan	Uttarakhand	Uttar Pradesh	Punjab	Assam	Chattisgarh	Delhi
<b>ToD Time Slots</b>												
Morning Peak	09:00-12:00	07:00-11:00	06:00-10:00	06:00-10:00	06:00-10:00	-	06:00-09:00	05:00-11:00	-	-	-	-
Evening Peak	18:00-22:00	18:00-22:00	18:00-22:00	18:00-22:00	18:00-22:00	-	18:00-22:00	17:00-23:00	18:00-22:00	17:00-22:00	18:00-23:00	22:00-01:00
Off-Peak Period	22:00-06:00	22:00-07:00	22:00-06:00	22:00-06:00	22:00-06:00	-	22:00-06:00	23:00-05:00	22:00-06:00	22:00-06:00	23:00-05:00	04:00-10:00
<b>ToD Consumer Category</b>												
HT Industrial	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes
HT Commercial	Yes	Yes	Yes	-	Yes	-	-	-	-	-	-	Yes
HT Others	Yes	Yes	Yes	-	Yes	-	-	-	-	Yes	Yes	Yes
LT Industrial	Yes	-	-	Yes	Yes	-	Yes	Yes	-	-	-	Yes
LT Commercial	Yes	-	-	-	-	-	-	-	-	-	-	Yes
LT Others	Yes	Yes	-	-	-	-	-	Yes	-	-	-	Yes
<b>Seasonal Tariff</b>												
Summer Months	-	-	-	-	-	-	April - September	April - September	June - September	-	-	May - September
Winter Months	-	-	-	-	-	-	October - March	October - March	October - March	-	-	-
Other Months	-	-	-	-	-	-	-	-	April-May	-	-	-
<b>Different Tariffs for Morning and Evening Peaks</b>												
	Yes	-	-	-	-	-	-	-	-	-	-	-
<b>Type of ToD Tariff</b>												
	Additional Rate	Additional Rate	Additional Rate	% of Normal Tariff	Additional Rate	-	Additional Rate	% of Normal Tariff	Additional Rate	Additional Rate	% of Normal Tariff	% of Normal Tariff



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## 2.4 Data Collection

ABPS Infra identified the data requirement and prepared the formats for facilitating providing of the data by TANGEDCO, and also explained the data requirement to the concerned officials. Based on our analysis, further clarifications were also sought from TANGEDCO, which were provided, and which have also been analysed in this Report. ABPS Infra has considered all data for the 2-year period from January 01, 2017 to December 31, 2018, in order to study the effect of seasonality and remove the effect of aberrations.

ABPS Infra has collected the following details from TANGEDCO for the study on ToD tariff:

1. **Demand and Consumption Details:** Details of month-wise contract demand, maximum demand, and billing demand for each HT category, and the time-slot wise consumption of each HT consumer (8,596 consumers in CY 2017 and 9,127 consumers in CY 2018).
2. **System Demand:** Demand data for TANGEDCO as whole for each month for 24 months from January 2017 to December 2018 (2 complete calendar years) for each time slot of half an hour.
3. **Supply Details:** Month-wise Source-wise power contracted in MW and source-wise power purchased in MU by TANGEDCO for each month for 24 months from January 2017 to December 2018 (2 complete calendar years), along with the associated cost of power purchase and rate of purchase.
4. **Load Generation Balance:** Data on how the half-hourly demand has been met by purchase from different sources of power purchase for 24 months from January 2017 to December 2018 (2 complete calendar years).

## 2.5 Baseline consumers considered

The existing ToD tariff is applicable only to HT 1A Industrial consumers as per the latest Tariff Schedule approved by the Commission. However, this study has not been



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limited to only HT 1A consumers but has been extended to all HT consumers and their contribution to peak hour consumption.

## 3 Demand Analysis

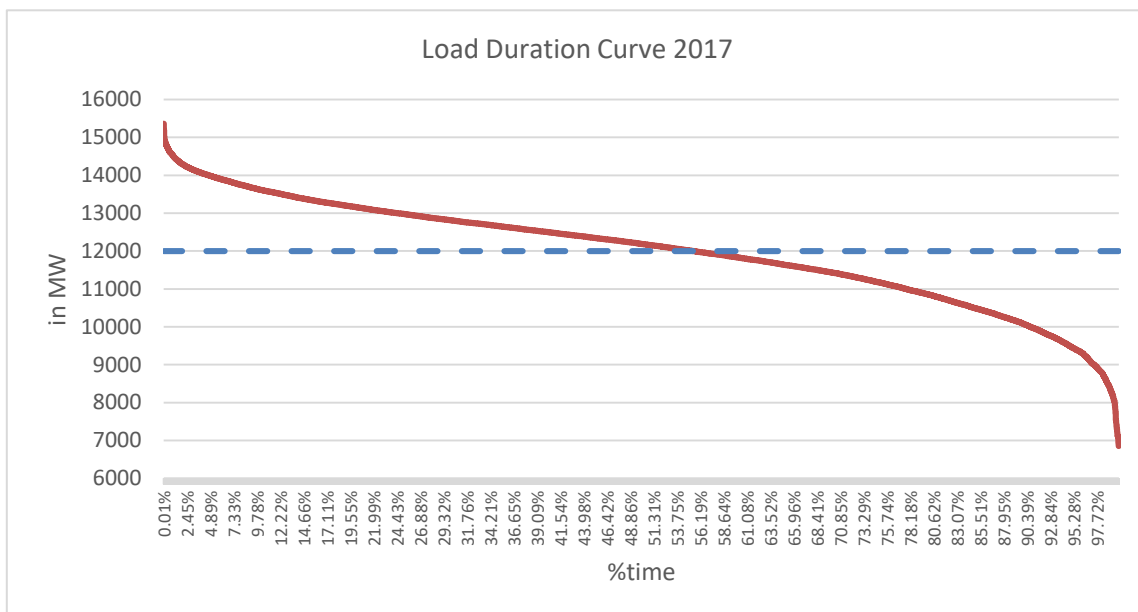
### 3.1 Analysis of Load Duration Curve

For analysis of overall demand for TANGEDCO and load duration curve, the data for every 30 min time block has been considered for 2017 (i.e., January 2017 to December 2017) and 2018 (i.e., January 2018 to December 2018).

The load duration curve is nothing but the curve between the load and time in which the load is plotted in the order of decreasing magnitude. This signifies the gradient of demand with time.

The load duration curve for 2017 is shown in the following Figure:

*Figure 1: Load Duration Curve CY 2017*



From the above load duration curve, it is observed that:

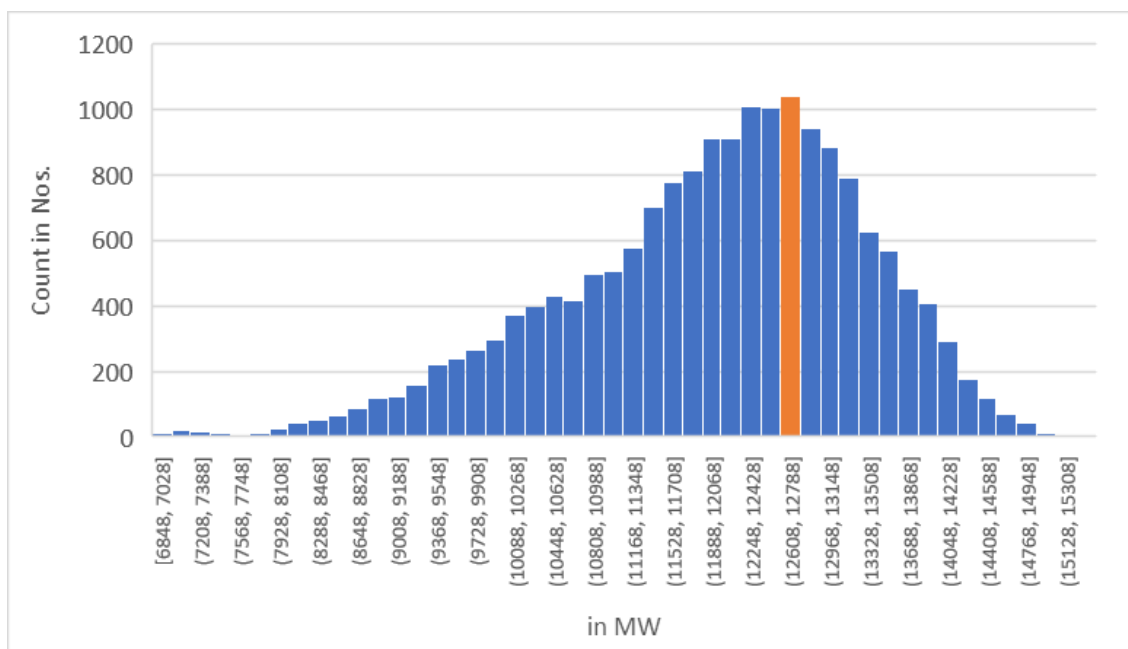
- (a) Maximum demand for CY 2017 is 15,361 MW, which had occurred on April 27, 2017 at 2300-2330 hours. Similarly, Minimum demand is 6,848 MW, which occurred on November 6, 2017 at 0300-0330 hours.



- (b) The variation between Maximum Demand and Minimum Demand is very large, to the extent of 8513 MW. This variation includes seasonal variation as well as daily variation.
- (c) Average demand for the year is 12,000 MW, which was recorded for 55.40% of time.
- (d) There is sudden decrease in the demand for shorter period of time at the lower end of curve. These data points need to be considered as outliers.
- (e) The Base Load for the Distribution Licensee has been derived by excluding the outliers and considering the equal spread from the average demand for the year. Considering the confidence interval of 5% and excluding outliers, the Base Load has been computed as 9,472 MW for CY 2017, which was recorded for 95% of the time.

Further, to analyse the frequency distribution of demand over the year, histogram has been plotted as shown in the following Figure:

Figure 2: Frequency Distribution of Demand - Histogram CY 2017

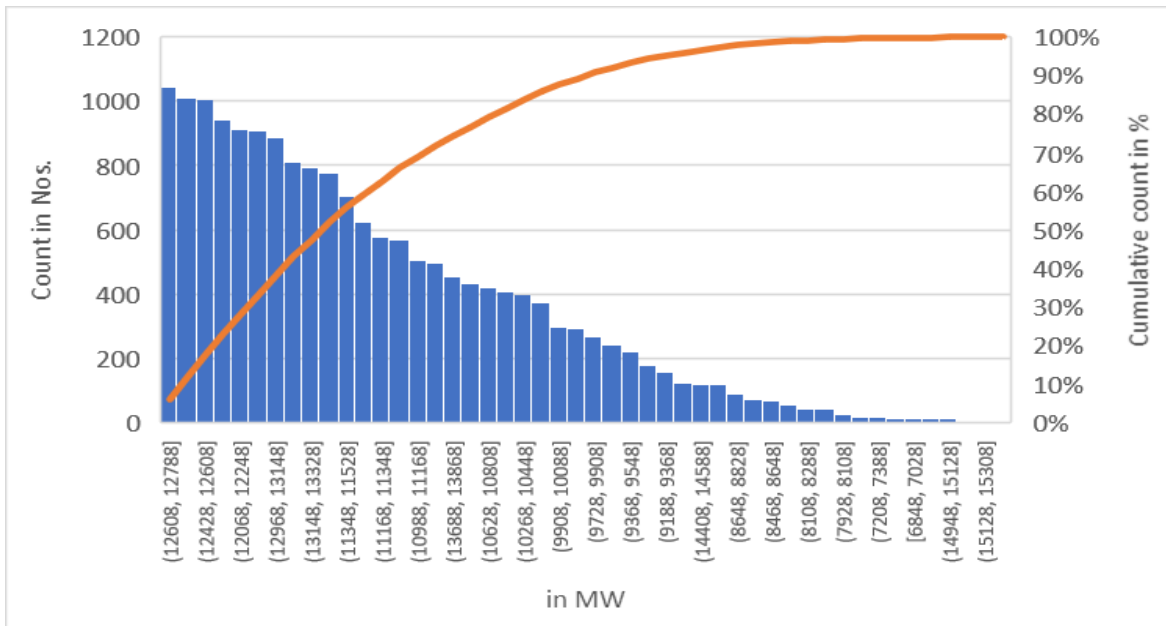


From the above graph, it has been observed that load demand of TANGEDCO during CY 2017 has followed normal distribution curve, which has been slightly skewed

towards Maximum demand. The standard variation ( $\sigma$ ) for load demand for CY is 1365 MW. The spread of load demand from average towards maximum demand is 2.46  $\sigma$ , however, the same is 3.77 towards minimum demand. The variation in lower demand than average demand is much larger during the period. This might be because of seasonal variation or drastic change in weather. Such lower demand creates the surplus power available for such particular period, if contracted capacity is equivalent to average demand.

To further analyse, the cumulative histogram has been shown in the following figure:

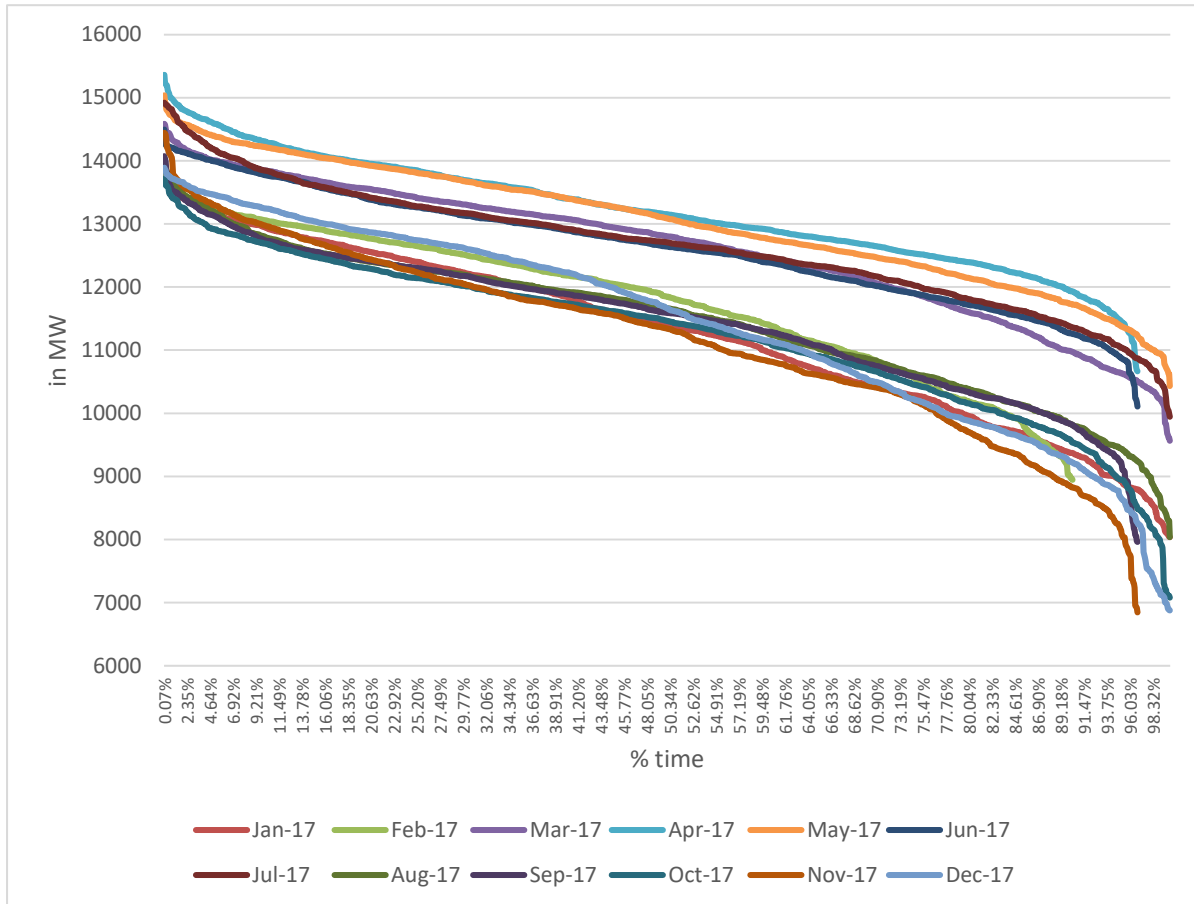
Figure 3: Cumulative Frequency Distribution of Demand - Histogram CY 2017



From the above, it is observed that, highest frequency distribution is for bin 12608 – 12788 MW, which is near to average demand of 12,000 MW. Also, the lower demand, which has skewed the frequency distribution curve, has contributed less than 5%.

It is further observed that the above said load duration curve is subject to daily variation as well as seasonal variation. To identify the seasonal variation, the monthly load duration curve has been plotted for CY 2017. The monthly load duration curves are shown in the following figure:

Figure 4: Monthly Load Duration Curve CY 2017

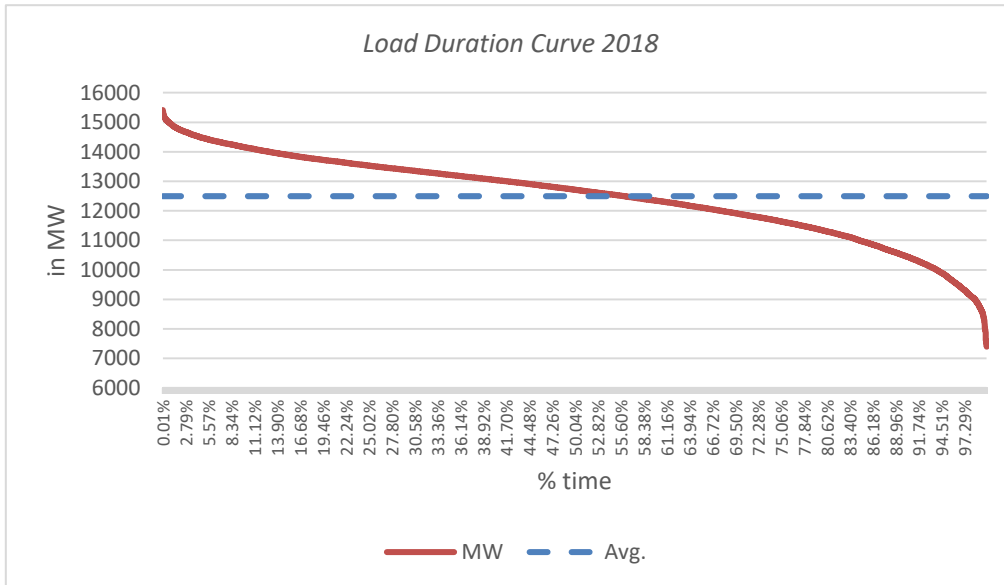


The above figure clearly captures the seasonal variation in load duration curve. There is clear bifurcation of two seasons. The demand in the months from March to July is much higher compared to demand in the months from August to February.

Further, it is noted that the Maximum Demand in all months varied from 15,361 MW to 13,716 MW i.e., variation of 1646 MW. The Minimum Demand varied from 10,663 MW to 6848 MW, i.e., variation of 3815 MW. As observed earlier, there is large variation in Minimum Demand during the months.

The load duration curve for 2018 is shown in the following Figure:

Figure 5: Load Duration Curve CY 2018

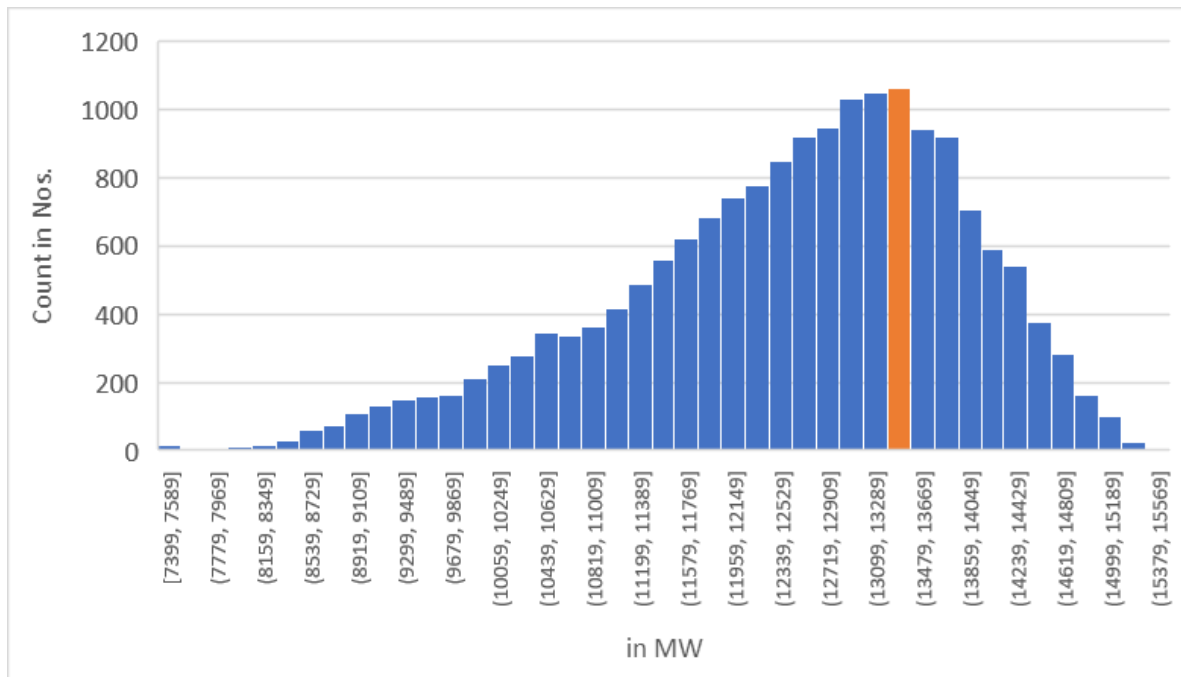


From the above load duration curve, it has been observed that:

- (a) Maximum Demand for CY 2018 is 15,411 MW, which had occurred on April 27, 2017 at 1900-1930 hours. Similarly, Minimum Demand is 7,399 MW, which had occurred on 15 January 2018 at 0300-0330 hours. The Minimum Demand for CY 2018 is higher than that of CY 2017.
- (b) The variation between Maximum Demand and Minimum Demand is very large, to the extent of 8013 MW. This variation includes seasonal variation as well as daily variation.
- (c) Average demand for the year is 12,497 MW, which was recorded for 55.95% of time.
- (d) There is sudden decrease in the demand for shorter period of time at the lower end of curve. These data points need to be considered as outliers.
- (e) The Base Load for the Distribution Licensee has been derived by excluding the outliers and considering the equal spread from the average demand for the year. Considering the confidence interval of 5% and excluding outliers, the Base Load has been computed as 9,815 MW for CY 2018, which was recorded for 95% of the time.

Further, to analyse the frequency distribution of demand over the year, histogram has been plotted as shown in the following Figure:

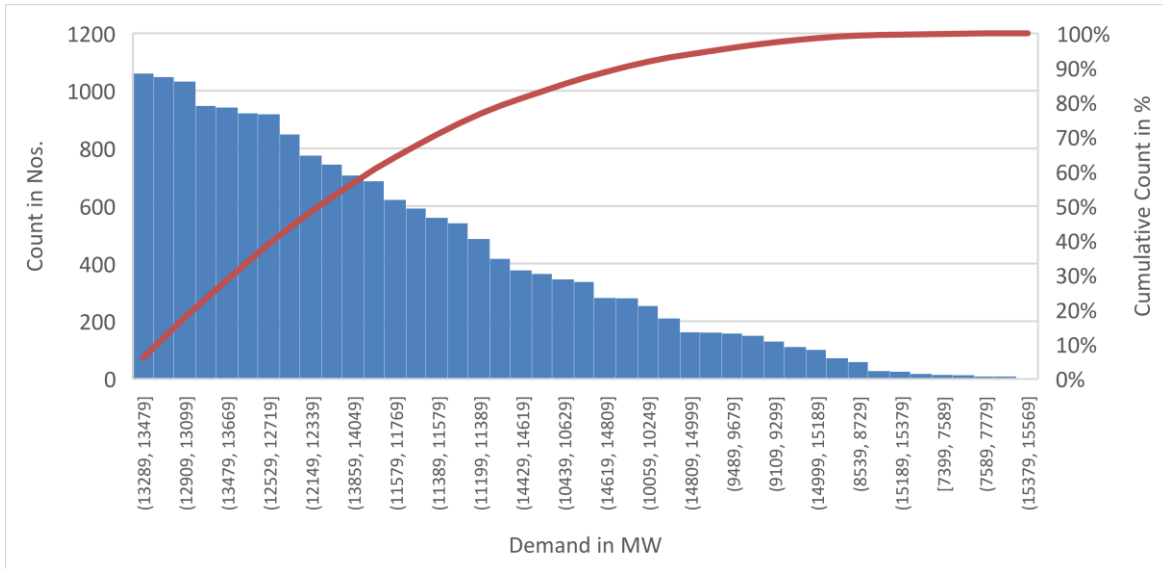
Figure 6: Frequency Distribution of Demand - Histogram CY 2018



From the above graph, similar to CY 2017, it is observed that demand of TANGEDCO during CY 2018 has followed normal distribution curve, which is slightly skewed towards Maximum Demand. The standard variation ( $\sigma$ ) for demand for CY 2018 is 1404 MW. The spread of demand from average demand towards maximum demand is 2.08  $\sigma$ , however, the same is 3.63 towards minimum demand. The variation between lower demand and average demand is much larger during the period. This might be because of seasonal variation or drastic change in weather. Such lower demand creates the surplus power available for such particular period, if contracted capacity is equivalent to average demand.

To further analyse, the cumulative histogram has been shown in the following figure:

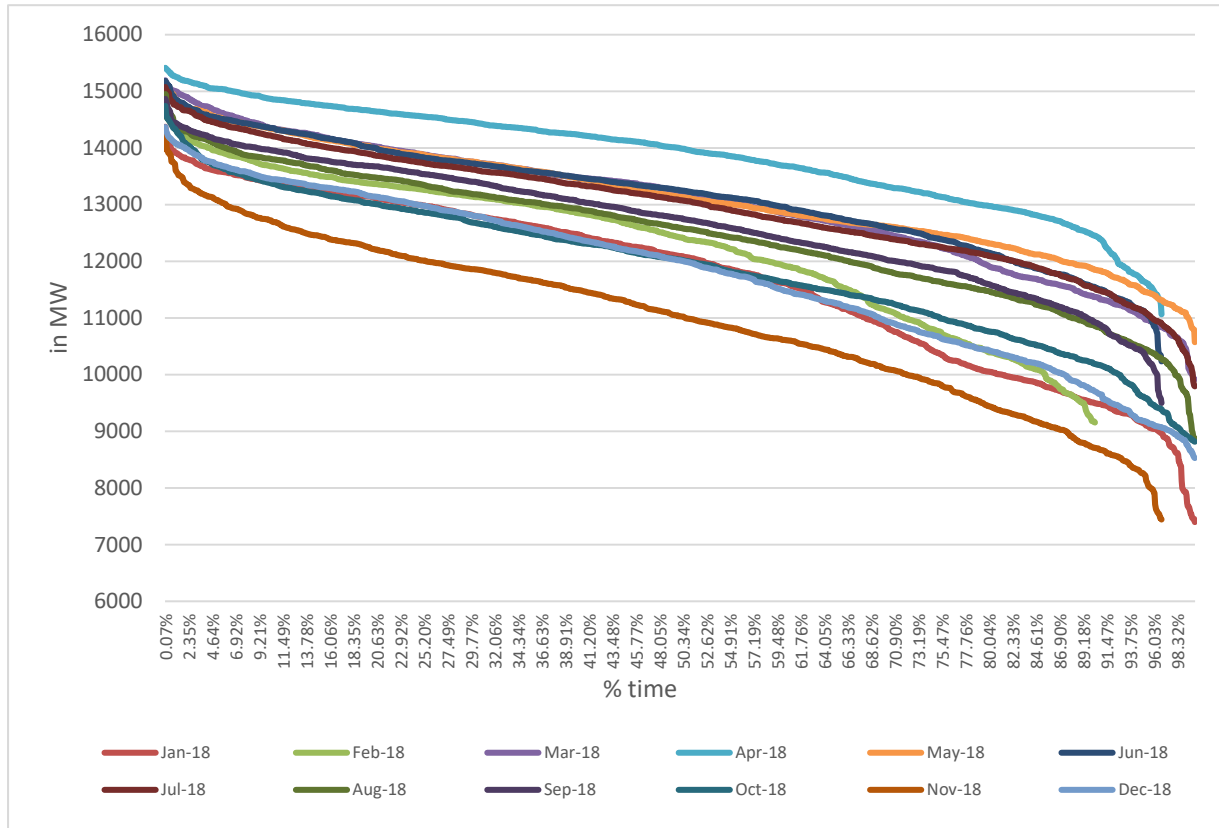
Figure 7: Cumulative Frequency Distribution of Demand - Histogram CY 2018



From the above, it has been observed that, highest frequency distribution is for bin 13289 - 13479 MW, which is slightly higher than average demand of 12,497 MW. Also, the lower demand, which has skewed the frequency distribution curve, has contributed less than 5%.

It is further observed that the above load duration curve is subject to daily variation as well as seasonal variation. To identify the seasonal variation, the monthly load duration curve has been plotted for CY 2018. The monthly load duration curves are shown in the following figure:

Figure 8: Monthly Load Duration Curve CY 2018



Unlike CY 2017, there is no clear demarcation between the seasonal variation in CY 2018. However, the demand in summer period seems to be much higher than rest of months. Further, it is noted that the Maximum Demand in all months varied from 15,411 MW to 14,281 MW, i.e., variation of 1130 MW. Also, Minimum Demand varied from 11,061 MW to 7399 MW i.e., variation of 3662 MW. As observed earlier, there is large variation in Minimum Demand during the months.

The load duration curve for both years are similar in nature. However, in CY 2017 there is clear demarcation of seasonal variation. The observations from load duration curve for CY 2017 and CY 2018 are summarised in the following Table:



Table 14: Summary of Load Duration Curve Analysis

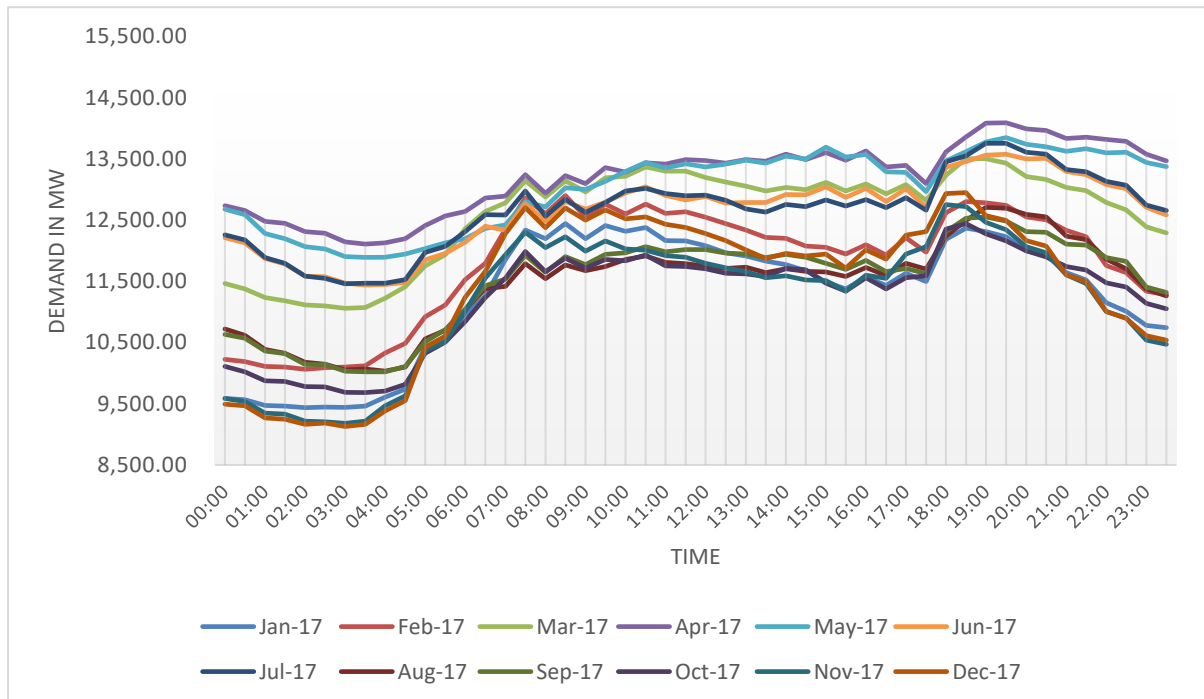
Sr. No.	Particulars	CY 2017	CY 2018
1	Maximum Demand	15,361 MW	15,411 MW
2	Minimum Demand	6,848 MW	7,399 MW
3	Average Demand	12,000 MW	12,497 MW
4	Range for highest frequency distribution	12,608 – 12,788 MW	13,289 – 13,479 MW
5	Diff. between Maximum and Minimum Demand	8,513 MW	8,013 MW
6	Sigma	1,365 MW	1,404 MW
7	Spread of Maximum Demand over Avg. Demand	2.46	2.08
8	Spread of Minimum Demand below avg. Demand	3.77	3.63
9	Seasonal variation for Maximum Demand	1,646 MW	1,130 MW
10	Seasonal variation for Minimum Demand	3,815 MW	3,662 MW
11	Seasonal variation for Average Demand	2,000 MW	2,874 MW

### 3.2 Analysis of Overall Demand and Demand Curves

As discussed in earlier Section of this Chapter, ABPS Infra has considered the demand data and plotted the load curve for the calendar years (CY) 2017 and 2018. Since the load data is available for each day for 30 min time block, i.e., a total of 17,520 data points has been considered. For analysis of demand curves, the average of demand for each time block in a month has been considered to plot the monthly load curve.

The monthly demand curves for CY 2017 is shown in the following figure:

Figure 9: Monthly Demand Curve for CY 2017

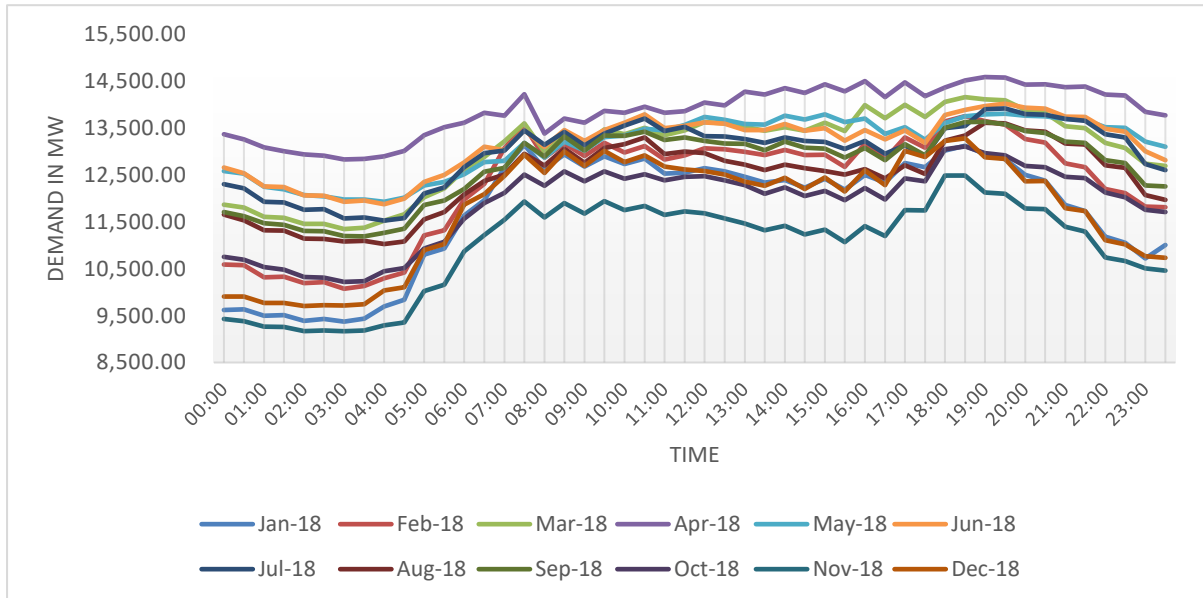


From the above demand curve, it has been observed that:

- (a) There is off-peak during night hours, then demand increases from 0500-0600 hours and attains peak around 0800-0830 hours. During afternoon hours demand remains almost flat before evening peak. There is a dip in demand before evening peak, around 1730 hours, in all months.
- (b) The daily variation in all months followed similar pattern except for March 17.
- (c) The evening peak has been clearly observed starting from 1730 -1800 Hours.
- (d) There is clear demarcation of two seasons wherein daily load curve are distinctly different. Also, there is large variation in demand for these two seasons during normal and off-peak hours. However, variation during peak hours is much lower.

Similarly, monthly demand curve for CY 2018 has been plotted as shown in the following figure:

Figure 10: Monthly Demand Curve for CY 2018

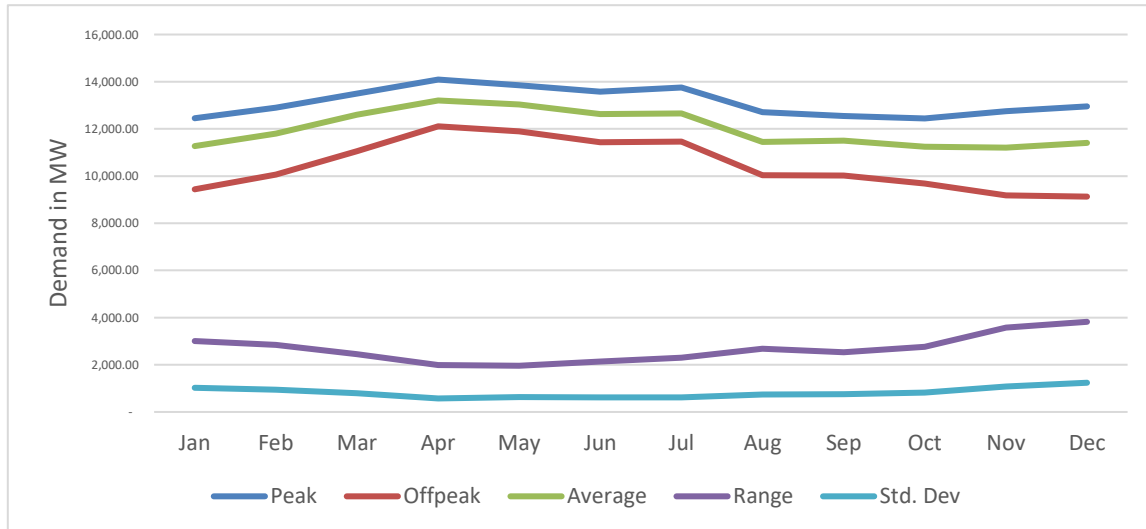


From the above demand curve, it is observed that:

- (a) Similar to CY 2017, there is off-peak during night hours, then demand increases from 0500-0600 hours and remains almost flat before evening peak. There is sudden dip before evening peak in all months.
- (b) The daily variation in all months followed similar pattern same as of CY 2017.
- (c) Unlike 2017, there is no clear demarcation of two seasons in 2018. However, the daily load curve for April 2018 is highest compared to other months. Similarly, the daily load curve for November 2018 is at bottom of all months. For all other months, daily load curve is within the range.

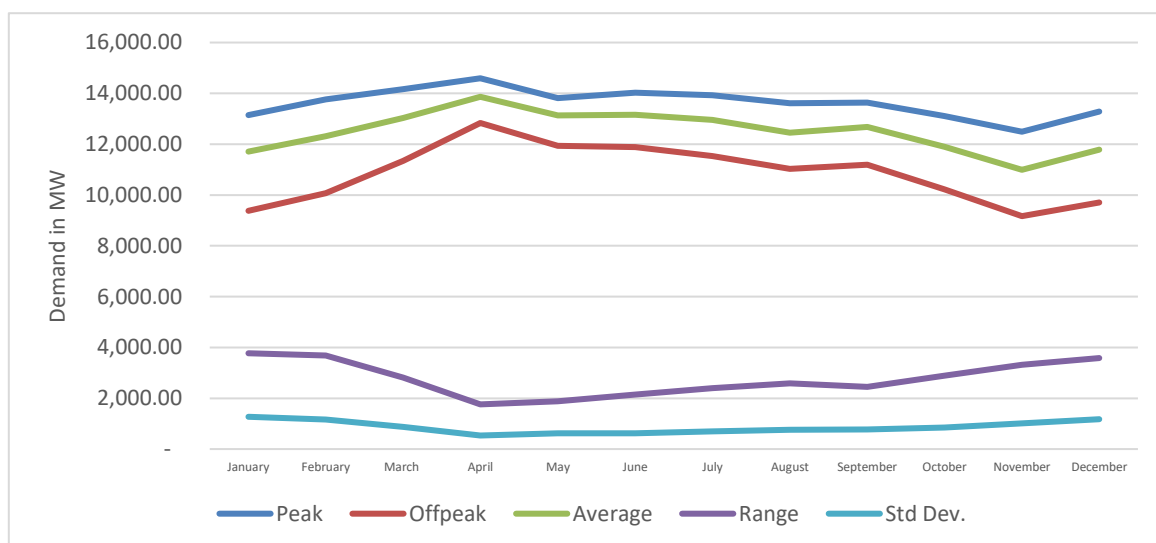
Further, it is noted that, for computation of monthly daily curve, average demand for particular time block has been considered. However, it is important to understand variation in demand in each time block. To further analyse the central tendency of load curve, variation in average demand has been calculated. The deviations from average gives an understanding of the fluctuation in demand in each month. The following graph shows the peak, off-peak, average load, and the range and standard deviation of the variation between the peak and off-peak demand.

Figure 11: Variation in Monthly Demand for CY 2017



As seen from the above graph, peak and off-peak demand is almost flat during the months of April to July and witness reduction of around 1500 MW to 2000 MW from August to February. The variation in range and standard deviation is highest in the months of November to January and almost in similar range during February to October. It can be concluded from the above graph that the deviations in peak and off-peak are lesser during months of April to July and significantly higher in the months of November to January.

Figure 12: Variation in Monthly Demand for CY 2018





The graph of CY 2018 is almost similar to that of CY 2017. The range increases in the months of October to February and decreases in the months of April to September.

For the variation analysis of average demand, it can be concluded that the difference between peak and off-peak demand is very less during the summer months as compared to the difference in peak and off-peak during winter months.

ABPS Infra has also identified the peak and off-peak day for 2017 and 2018 based on the demand data provided by TANGEDCO, as shown in the Table below:

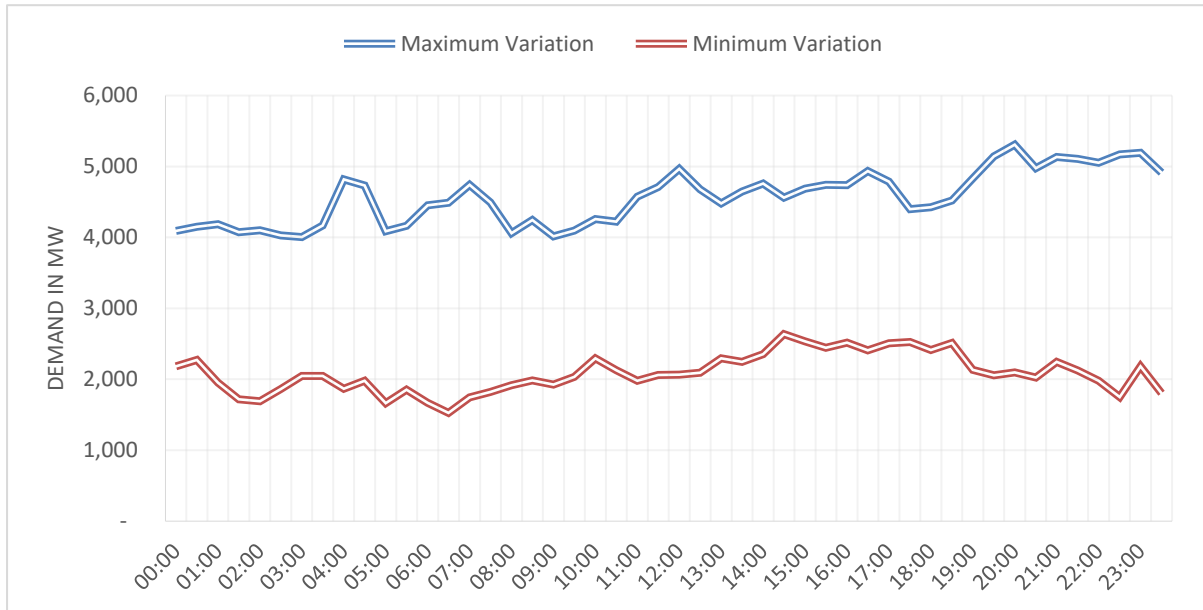
*Table 15: Peak and Off-Peak days*

<b>Particulars</b>	<b>2017</b>	<b>2018</b>
Peak Day	27-04-2017	27-04-2018
Off-peak Day	06-11-2017	15-01-2018
Highest Ave Demand Day	05-05-2017	27-04-2018
Lowest Ave Demand Day	03-12-2017	06-11-2018

Peak days are observed in the month of April, while off-peak day has been observed in November 2017 and January 2018.

The above monthly demand curve is a reflection of both, daily variation and seasonal variation. Moreover, seasonal variation is clearly visible as discussed above. Further, it is noted that, for computation of monthly daily curve, average demand for particular time block has been considered. It is important to understand the variation in each time block during the month.

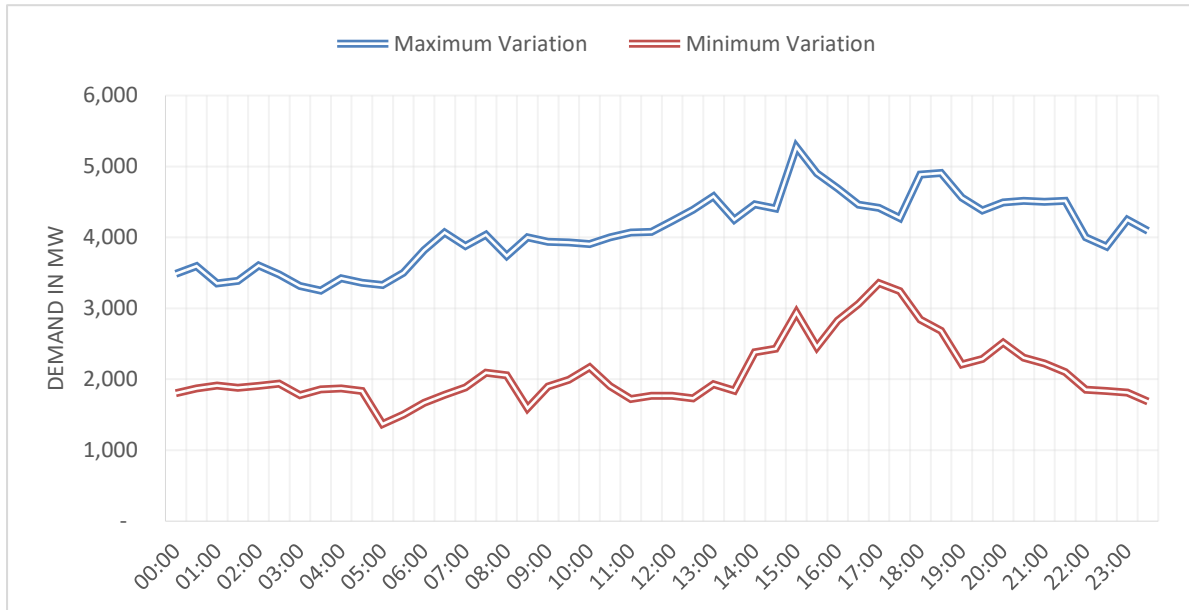
Figure 13: Variation in Monthly Demand for CY 2017



The above graph indicates the boundary between the variation in each time block. This also includes the seasonal variation. During 2100 to 2300 hours, the variation increases as compared to other time periods.

However, the variation of CY 2018 shows completely different pattern. There is less variation during peak hours. Moreover, variation is higher during afternoon hours.

Figure 14: Variation in Monthly Demand for CY 2018



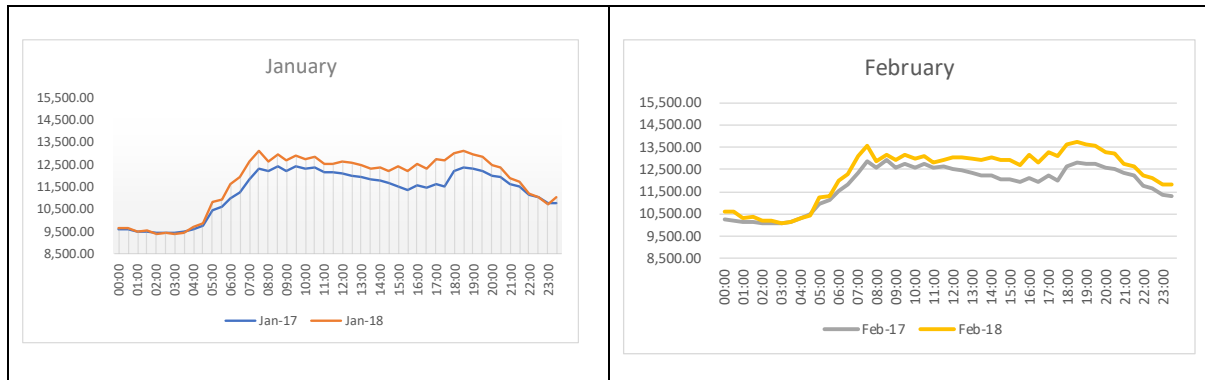
Hence, the limits of daily variation are not having any fixed pattern. However, in monthly demand curves, it has been observed that these daily curves are following similar pattern. The demand in each day would be different and depends on other factors like temperature, area demand variation, instantaneous load, etc.

For the purpose of this study, the load data has been considered for two years. It is required to analyse whether there is substantial difference on year on year basis. Hence, the monthly load curves are further analysed as under:

The following graphs shows the load curve for each month of CY 2017 and CY 2018.

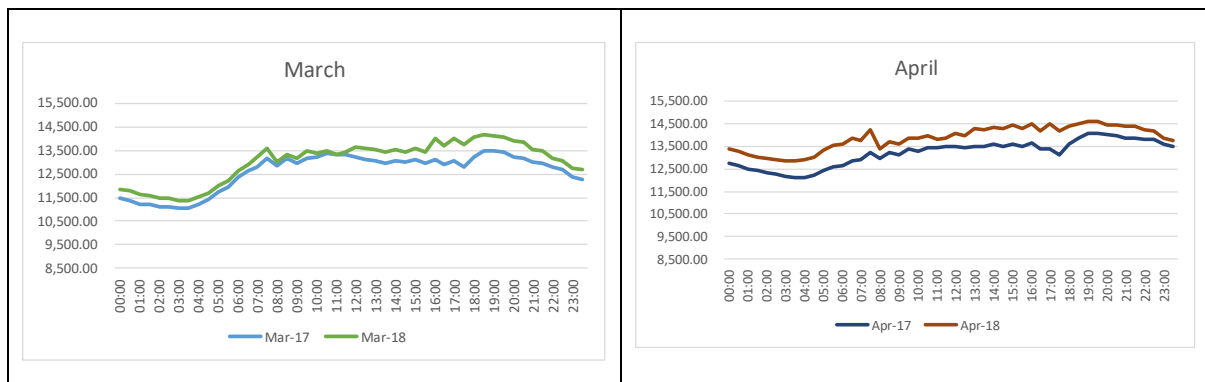


Figure 15: Load Curve of Jan and Feb 2017 and 2018



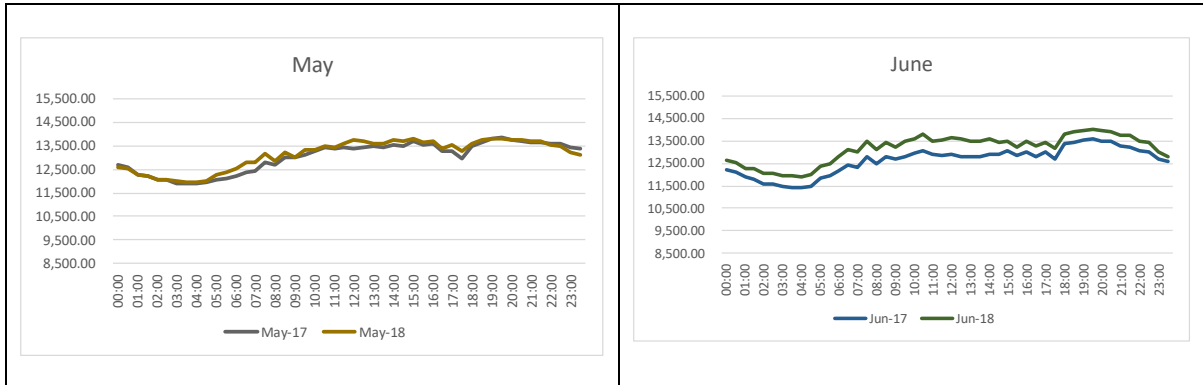
The load curve is almost similar for all time slots during both the months, with the load curve for 2018 at a higher level of demand, and the demand in the off-peak hours in February at a higher level than that in January. A morning peak is observed between 7:00 hrs to 10:00 hrs and evening peak is observed during 18:00 hrs to 20:00 hrs.

Figure 16: Load Curve of Mar and Apr 2017 and 2018



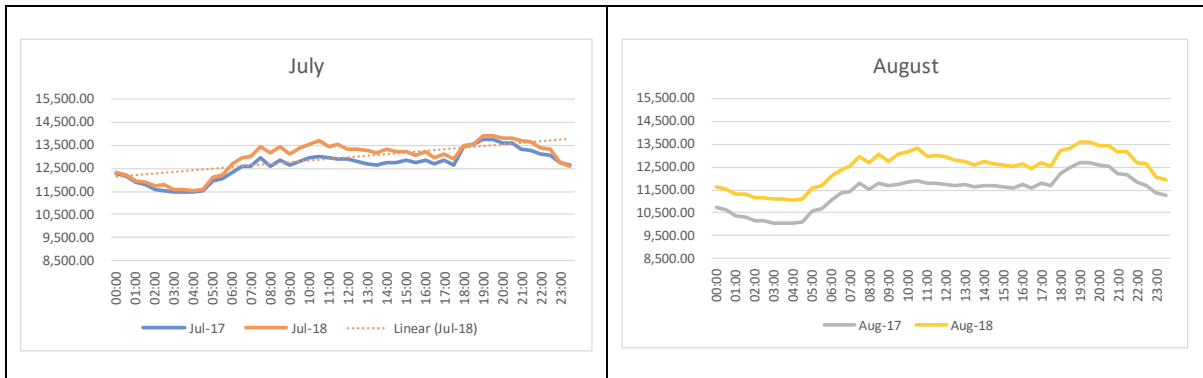
The load curve for March curve is similar to the load curve of Jan and Feb, with the night consumption higher in March as compared to Feb. Further, load curve of April is slightly different from that in previous months. The peak demand during April is higher as compared to Jan, Feb and March in the morning as well as evening hours, and the off-peak demand is also higher than that of March. Moreover, the load curve is almost flat throughout the day as compared to the previous months.

Figure 17: Load Curve of May and June 2017 and 2018



The load curve for May is similar to that in April. The evening peak starts from 18:00 hrs and continues till 23:00 hrs. The demand is constant even in afternoon hours and is similar to the demand during peak hours. The load curve in June is almost flat throughout the day. The demand during afternoon is almost similar to morning peak and there is a slight jump in demand during the evening hours.

Figure 18: Load Curve of July and Aug 2017 and 2018



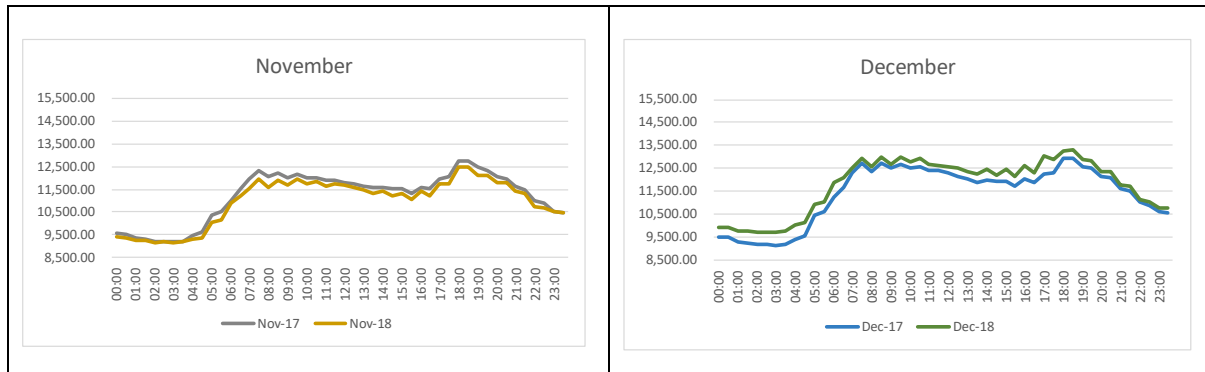
The load curve for July is almost linear with a spike during evening hours. However, during July and August, the overall demand is lower. The significant deviation is observed between the load curves of CY 2017 and CY 2018.

Figure 19: Load Curve of Sep and Oct 2017 and 2018



The load curve of September and October is similar to that in August where there is no significant reduction during afternoon hours. However, during October, overall demand is lower including morning and evening peak and off-peak demand as compared to previous months.

Figure 20: Load Curve of Nov and Dec 2017 and 2018



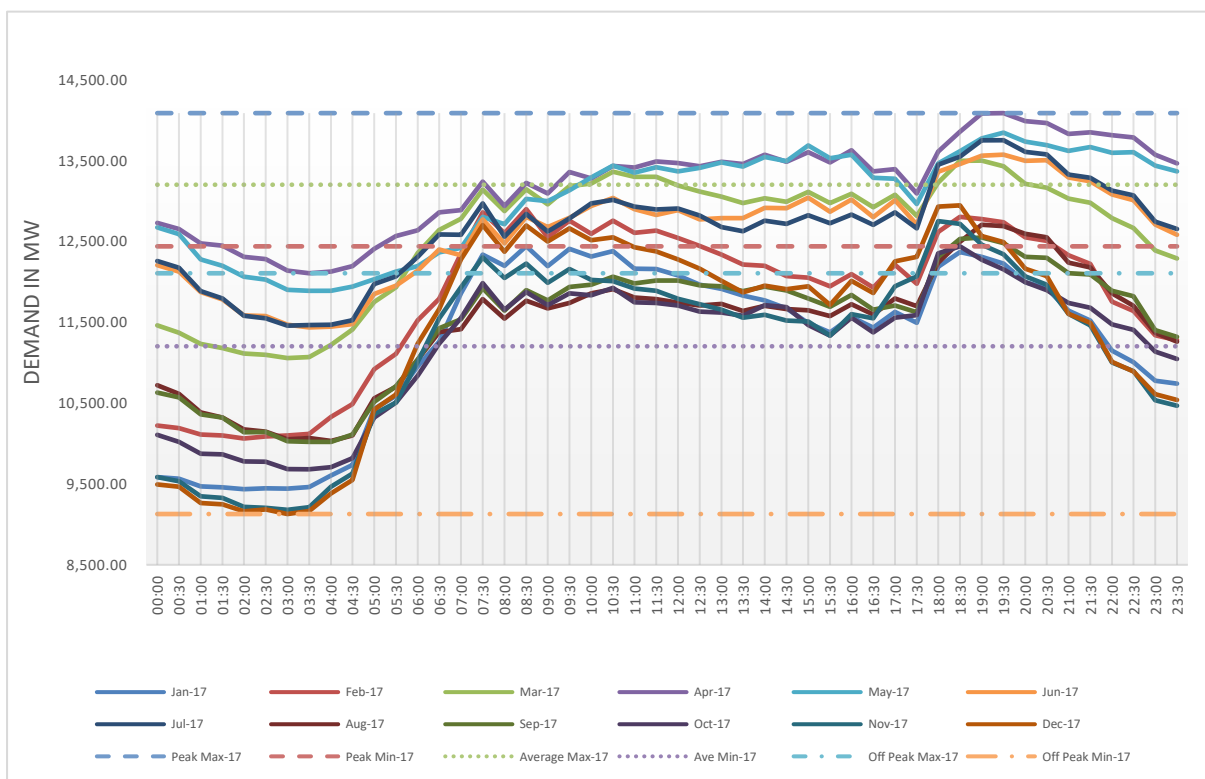
The graphs for November and December are almost similar. The demand for November is considerably lower as compared to the demand in December. We can see a declining trend in the afternoon hours between morning and evening peaks.

As seen from the above graphs, there is a significant difference in load curves for each month. There are two peaks during the day, with the load reducing slightly during the day from the morning peak and then increasing during evening peak hours. The following graph shows all the monthly demand curve for CY 2017 taken together in order to understand monthly trend in demand.

### 3.3 Establishment of Time of Day slots

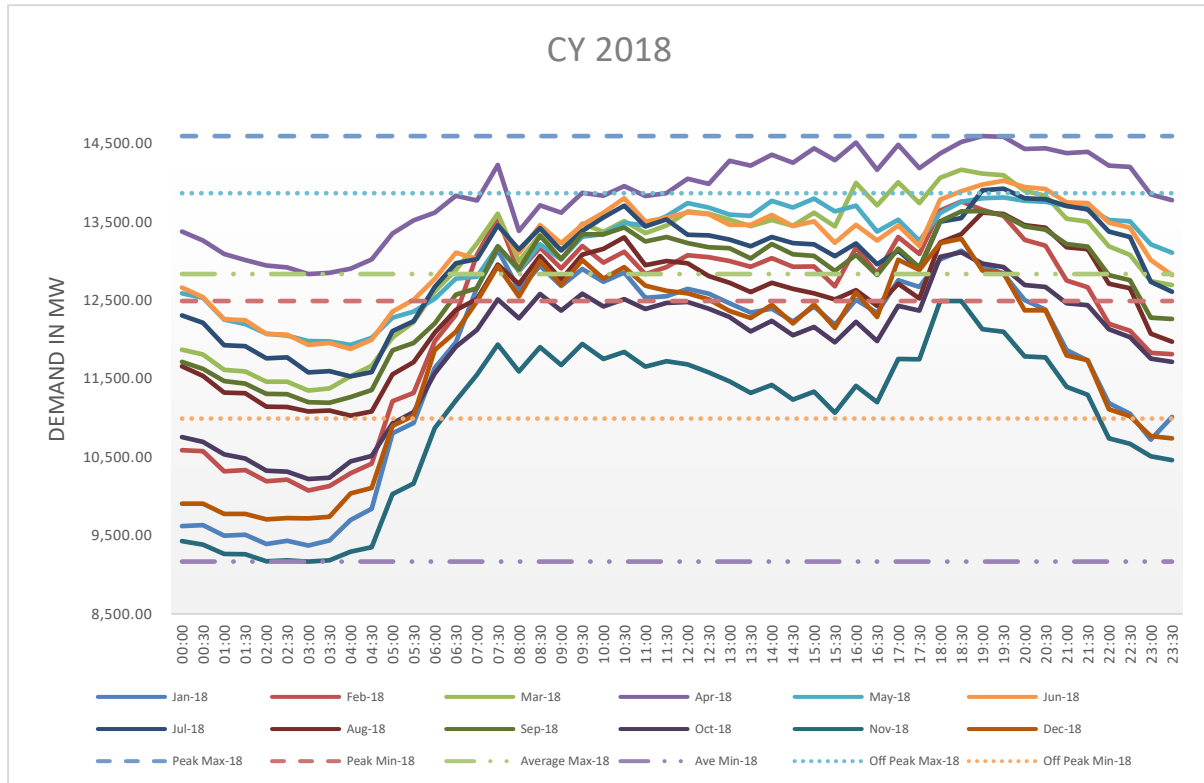
For establishment of Time of Day slots, monthly demand curves have been analysed, considering the central tendency and variation analysis. The following figure shows the monthly demand curves for CY 2017 along with limits of Peak and off-peak demand.

Figure 21: Monthly Demand Curves for CY 2017



As seen from the above graph, the maximum and minimum demand during peak hours is around 14,100 MW and 12,400 MW, respectively. The maximum and minimum demand during off-peak hours is around 12,000 MW and 9,100 MW, respectively. The average maximum demand is around 13,000 MW and average minimum demand is around 11,000 MW.

Figure 22: Monthly Demand Curves for CY 2018



As seen from the above graph, the maximum and minimum demand during peak hours is around 14,000 MW and 12,300 MW, respectively. The maximum and minimum demand during off-peak hours is around 12,500 MW and 9,000 MW, respectively.

As observed from the above graph, the peak observed during morning hours combined for all the months is still less than the average maximum demand for all months, whereas the evening maximum peak is higher by almost 1,000 MW as compared to the average peak.

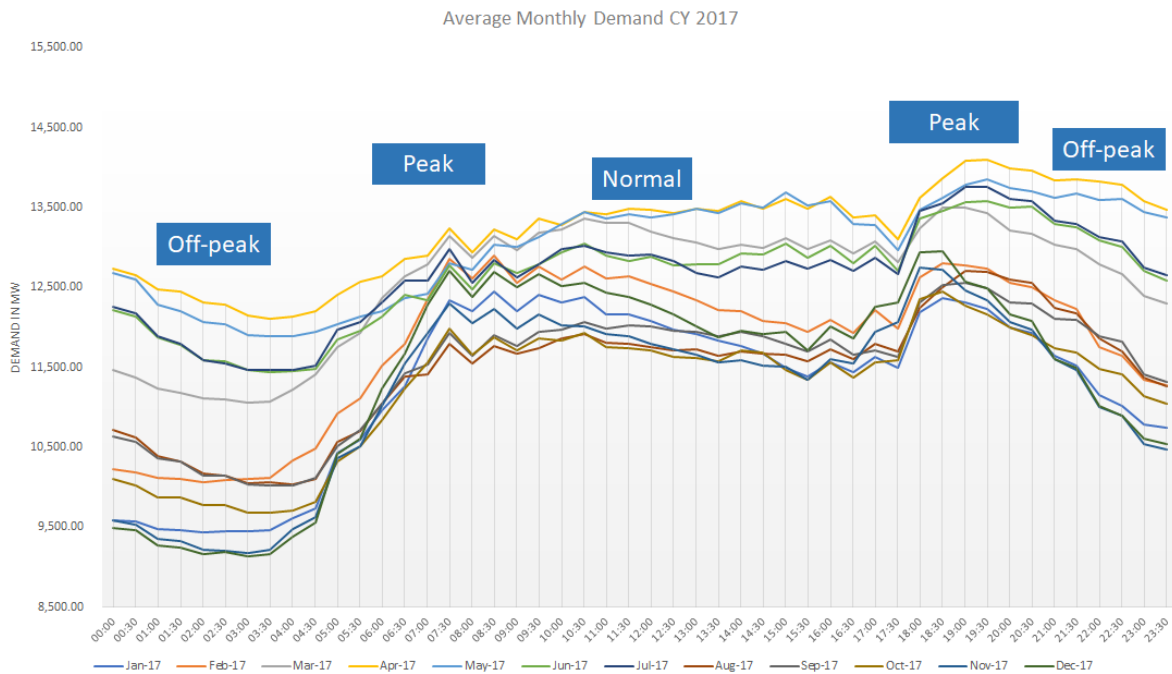
The load is highest in the month of April, followed by May, June and July. The load is lowest in the month of December, followed by November and January.

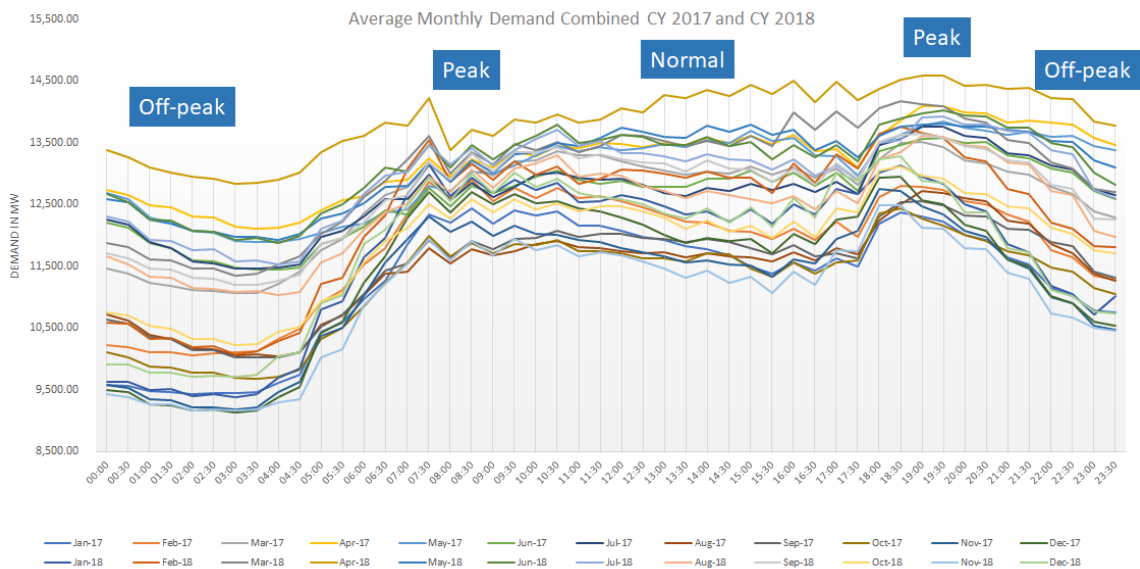
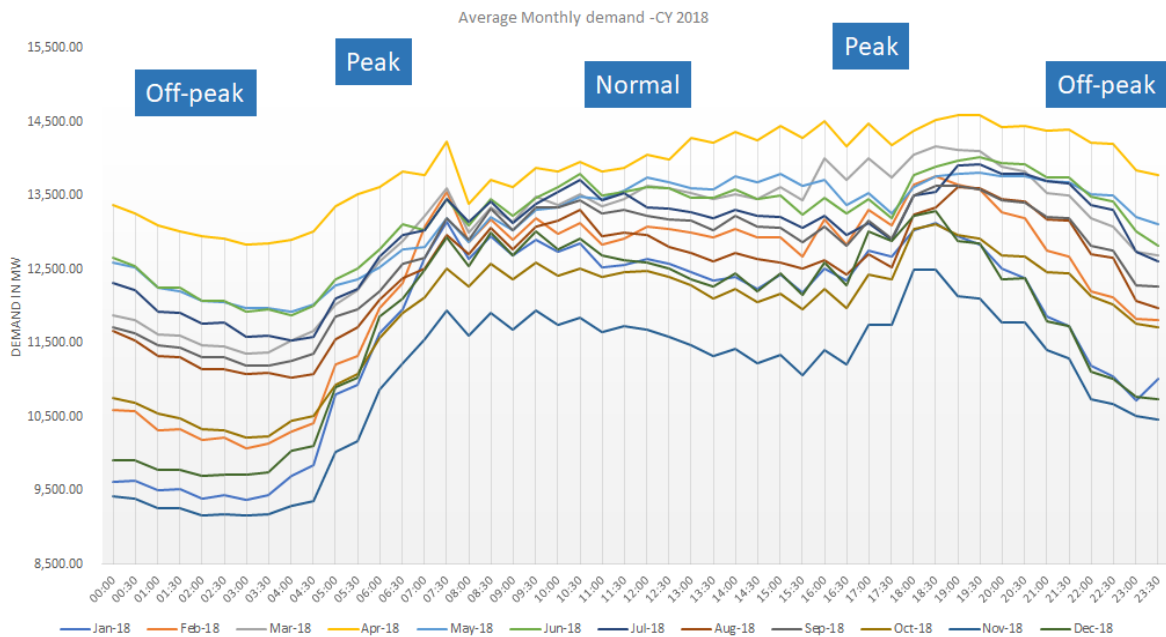
It can be also observed the demand between the morning and the evening peaks for almost all the months is in the range of average minimum and maximum demand, i.e.,

between the red lines shown in the above graph. The evening peak can be easily identified from the graphs for each of the months, while the morning peak is less distinct, as the demand dips only a bit during the day after attaining the morning peak.

The following graph shows the variation in load curves and the slots to be considered as peak and off-peak considering the data for CY 2017 and CY 2018.

Figure 23: Peak and Off-peak Time slots





It can be observed from the above graph that the morning peak starts from 06:30 AM and continues till 10:30 AM and the evening peak starts from 18:00 Hrs to 22:00 Hrs. The night hours are usually off-peak, and the afternoon hours can be considered under normal hours.



The proposed ToD slots based on the above study and analysis are:

1. 22:00 Hrs to 05:00 Hrs – Off-peak Period
2. 05:00 Hrs to 6:30 Hrs – Normal Period
3. 6:30 Hrs to 10:30 Hrs – Morning Peak Period
4. 10:30 Hrs to 18:00 Hrs – Normal Hours
5. 18:00 Hrs to 22:00 Hrs Evening Peak Period

**It is to be noted that the evening peak is significantly higher than the morning peak and therefore the charges for evening peak hours may be higher as compared to the morning peak hours, unlike the existing tariff structure where the peak period charges are same for morning peak hours as well as evening peak hours.**

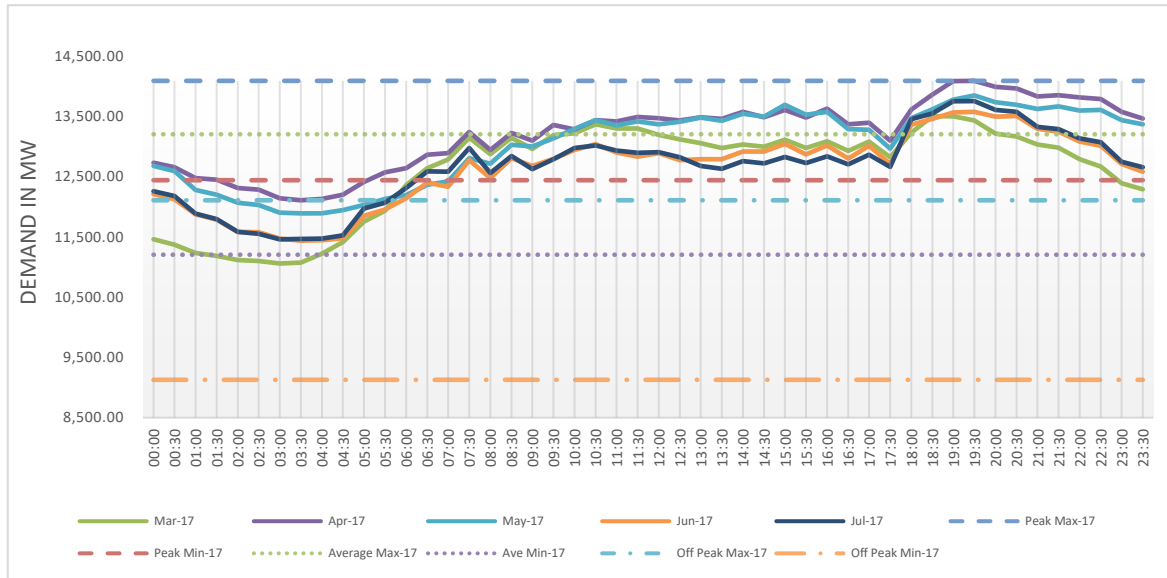
With reference to the load curve plotted in the previous Chapter, it was observed that there is a deviation in the curves during the year. The plot clearly showed that one set of data points show a similar range of demand during the year and the other set of data points show a different demand during the year.

Based on the load curve, the two sets of months which are similar in demand are

1. March to July – Season 1
2. August to February – Season 2

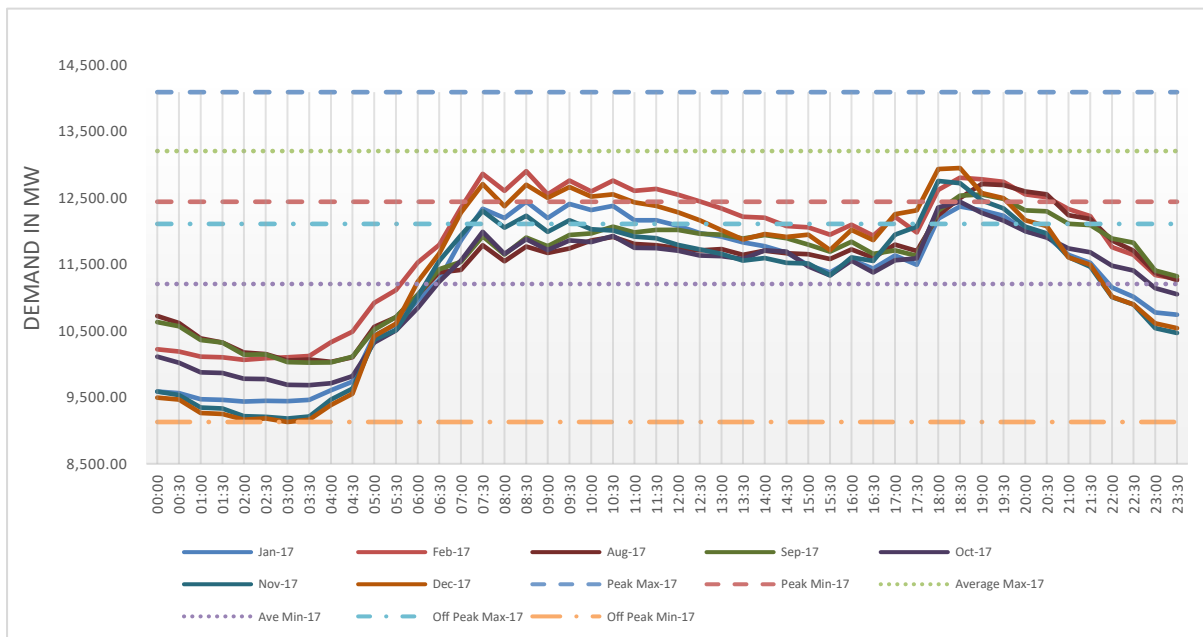
The above set of months have been categorized as Season 1 and Season 2, respectively. The separate load curve for the above-mentioned months have been compiled to check on any co-relation between the two Seasons. The following figure shows the load curve of Season 1:

Figure 24: Load Curve of Season 1



As seen from the above graph, it is observed that the morning peak cannot be termed as a peak during Season 1 as the morning demand is almost constant or rather increasing during the afternoon hours. However, the evening peak is a significant spike during Season 1, where the demand met is the highest during the year.

Figure 25: Load Curve of Season 2



As seen from the above graph, the demand attains a morning peak and then recedes during the afternoon hours. During the evening hours, it again rises to the same level as the morning peak demand and then declines in the night hours. Thus, Season-2 shows a completely different trend in load curve as compared to Season-1. The demand curve of Season 1 remains almost flat from early morning hours to afternoon hours, whereas Season 2 clearly touches a peak and then declines during afternoon hours.

The morning peak achieved during both the Seasons is almost same while there is a significant difference in the evening peak demand between both the Seasons. The demand in off-peak hours in Season 1 does not go below 11,000 MW while demand in off-peak hours in Season 2 is as low as 9,000 MW.

The variance between peak and off-peak demand is more during Season 2, while it is comparatively lesser in Season 1.

It can be hence concluded that there are seasonal variations in demand during the year and accordingly the ToD rates may be designed for better recovery of cost of power purchase.

**It is proposed that ToD charges for peak and off-peak may be determined for Season-1 and Season 2 separately since the demand pattern is different.**

**It is also proposed that the ToD tariff shall be same for morning peak and evening peak for Season-2. However, different ToD tariff may be notified for morning peak and evening peak in Season 1.**

### **3.4 Category-wise Consumption Pattern**

The Commission vide Tariff Order dated 11th August 2017 had directed as under regarding implementation of ToD charges:

*“ii. Identify the contribution of each category towards the peak consumption and which category can shift its consumption to off-peak hours, seasonal variation in the peak and off-peak consumption levels.”*

ABPS Infra has accordingly worked out the consumer category, which contributes towards peak consumption. In the next chapter, ABPS has analysed the contribution of demand of consumer categories during different time slots and their ability to shift consumption to off-peak hours and; accordingly given its recommendation.

ABPS Infra has collected month-wise and circle-wise data for contract demand, maximum demand, billing demand and consumption in each existing time slots for the period from Jan 2017 to Dec 2018 for all HT categories. ABPS Infra has studied data of total 8,596 nos. of HT consumers for CY 2017 and 9,127 nos. of HT consumers for CY 2018. ABPS Infra has analysed the data and worked out the category-wise consumption pattern during peak and off-peak period. The data provided for consumption is based on the existing ToD slabs that are programmed in the meters. ABPS has considered the consumption of different ToD slabs proportionately to work out half hourly consumption of such HT consumers. The category wise consumption for CY 2017 is shown in the following Table:

Table 16: TOD Slot-wise consumption for CY 2017 (in MU)

Particulars	0600-0900 hours	1800-2100 hours	2100-2200 hours	0500-0600 & 0900-1800 hours	2200-0500 Hours	Total
	<i>Peak</i>	<i>Peak</i>	<i>Normal</i>	<i>Normal</i>	<i>Off-peak</i>	<i>All day</i>
<b>Commercial</b>	20.91	11.86	19.86	1,655.81	27.07	1,735.51
<b>Industrial</b>	2,949.77	3,055.25	1,075.70	10,626.88	6,903.82	24,611.42
<b>Railways</b>	184.17	283.44	136.42	1,925.68	399.14	2,928.85
<b>Others</b>	5.14	5.45	2.53	793.68	16.04	822.84
<b>Grand Total</b>	<b>3,159.99</b>	<b>3,355.99</b>	<b>1,234.50</b>	<b>15,002.05</b>	<b>7,346.06</b>	<b>30,098.59</b>
<b>% Contribution</b>	10.50%	11.15%	4.10%	49.84%	24.41%	100%

It has been observed that more than 50% of consumption lies in normal hours. Around 10-11% of consumption is contributed by consumption of Morning and Evening peak hours. The off-peak hours contributed around 24% of consumption.

Similarly, the category wise consumption for CY 2018 is shown in the following Table:

Table 17: TOD Slot-wise consumption for CY 2018 (in MU)

Particulars	0600-0900 hours	1800-2100 hours	2100-2200 hours	0500-0600 & 0900-1800 hours	2200-0500 Hours	Total
	<i>Peak</i>	<i>Peak</i>	<i>Normal</i>	<i>Normal</i>	<i>Off-peak</i>	<i>All day</i>
<b>Commercial</b>	35.30	33.97	15.48	1,473.91	78.91	1,637.57
<b>Industrial</b>	2,837.14	2,968.47	1,018.87	10,035.11	6,652.70	23,512.29
<b>Railways</b>	201.89	312.14	101.49	1,789.92	440.90	2,846.34
<b>Others</b>	7.63	8.78	2.85	703.77	19.97	743.01
<b>Grand Total</b>	<b>3,081.96</b>	<b>3,323.36</b>	<b>1,138.70</b>	<b>14,002.71</b>	<b>7,192.48</b>	<b>28,739.20</b>
<b>% Contribution</b>	10.72%	11.56%	3.96%	48.72%	25.03%	100%

Similar to CY 2017, more than 50% of consumption lies in normal hours. Around 10-11% of consumption is contributed by Morning and Evening peak hours. The off-peak hours contributed around 25% of consumption.

As seen from the above table, HT Industry is the biggest contributor to the consumption. The contribution of HT Commercial and HT Railways to peak hour consumption is quite low in comparison.

The contribution of each category in total demand is computed based on the monthly consumption of each category. ABPS Infra has worked out the average monthly demand for each category considering the average billing demand and consumer utilisation factor.

Further, the remaining demand has been apportioned to LT consumers. TOD meters are currently not installed for all LT consumers and therefore, TOD consumption data for LT consumers is not available. Based on the analysis, the category wise contribution has been computed as under for CY 2017 and CY 2018:

Table 18: Category wise contribution to total demand for CY 2017

Particulars	0600-0900 hours	1800-2100 hours	2100-2200 hours	0500-0600 & 0900-1800 hours	2200-0500 Hours
<b>LT Categories</b>	78.42%	78.44%	75.56%	69.02%	78.21%
<b>HT Commercial</b>	0.15%	0.08%	0.43%	3.38%	0.08%
<b>HT Industrial</b>	20.12%	19.60%	21.14%	21.90%	20.46%
<b>HT Railways</b>	0.04%	0.04%	0.06%	1.77%	0.05%
<b>HT Others</b>	1.28%	1.85%	2.82%	3.93%	1.20%

Table 19: Category wise contribution to total demand for CY 2018

Particulars	0600-0900 hours	1800-2100 hours	2100-2200 hours	0500-0600 & 0900-1800 hours	2200-0500 Hours
<b>LT Categories</b>	79.02%	78.59%	77.30%	71.48%	78.36%
<b>HT Commercial</b>	0.18%	0.17%	0.18%	3.07%	0.20%
<b>HT Industrial</b>	19.40%	19.20%	20.46%	20.19%	20.07%
<b>HT Railways</b>	0.06%	0.06%	0.06%	1.61%	0.07%
<b>HT Others</b>	1.35%	1.98%	1.99%	3.65%	1.30%

As seen from the above, HT Industry contribution is significant as compared to other HT categories in the State.

It is also noted that contribution of LT categories in total demand of TANGEDCO is significant. However, at present, TOD Tariff is only applicable to HT Industrial category, and no TOD tariff is applicable to LT categories. In many States, it has been observed that TOD tariff has also been made applicable to LT Commercial, LT Industrial categories and HT Commercial categories. Though there is no data at present, as TOD tariffs have not been implemented for LT categories, it is well known that LT Commercial and LT Industrial categories contribute significantly to the load during peak hours. Further, the tariff for LT Industrial and HT Industrial category is same, except for the applicability of TOD tariffs for HT category, at present. This has resulted in a perverse incentive to consumers to split their connections, so that they are able to qualify to get LT connections, and not be subjected to levy of TOD tariff. In



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view of the above, the extension of TOD tariff to LT Commercial and LT Industrial categories needs to be seriously considered.

## 4 Meeting Demand Supply Gap

### 4.1 Peak Energy Requirement and Cost of Peak Energy

TANGEDCO has provided source-wise power purchase in MW for period from Jan 2017 to Dec 2018 for each half hour time slot. Based on the demand data analysis, the peak energy requirement has been computed for Morning Peak as well as Evening Peak. It is to be noted that peak energy requirement has been derived from 30 minute block-wise demand data. The underlying assumption is that the said demand is constant for the 30-minute block and the energy consumption for such time block has accordingly been computed. However, in actual, the energy consumption might be different because it is actual recorded energy and the variation in demand within such time block has also been captured.

For computation of total energy purchased and peak energy purchased, the demand for each 30 minute time block has been considered, i.e., total 17,520 data points each for CY 2017 and CY 2018. Total energy purchased in each time block has been calculated after considering the demand. After taking into account daily variation and seasonal variation, the monthly base load has been computed for both years. The demand above Base Load and the corresponding energy purchased in each month have been computed.

Accordingly, the total energy purchased round the clock and peak energy purchased towards Peak period as defined in existing Time of Day time-slots for CY 2017 and CY 2018, are shown in the following Table:

*Table 20: Peak Energy Purchased for CY 2017 and CY 2018*

Sr. No.	Details of Energy purchased	CY 2017	CY 2018
1	Evening Peak period (1800 -2200 hours)	2,345	2,388
2	Morning Peak period (0600-0900 hours)	1,788	1,871
3	Normal Period (0500-0600, 0900-1800 & 2100-2200 hours)	7,963	8,252
4	Off-peak period (2200 - 0500 Hours)	3,812	3,769



Sr. No.	Details of Energy purchased	CY 2017	CY 2018
5	<b>Grand total</b>	<b>15,908</b>	<b>16,281</b>

From the above table, it has been observed that, during CY 2017, total peak energy purchased is 4,133 MU and the same is 4,260 MU in CY 2018, which works out to 26% of the total power purchased in both the Years.

For meeting this energy, the sources of power have been considered from the highest rank in the Merit Order stack in descending order, based on actual purchase. It has been observed that, peak energy purchased was primarily met through energy purchased from the Power Exchange. For the purpose of computing cost towards such peak energy purchased, the month-wise weighted average rate of energy purchased from Power Exchange has been multiplied by energy purchased in peak period as mentioned above. Accordingly, the cost of peak energy purchased is computed as shown in the following Table:

*Table 21: Cost of Peak Energy Purchased for CY 2017 and CY 2018*

Sr. No.	Particulars	CY 2017	CY 2018
1	Energy purchased in Morning Peak period and Evening Peak Period (MU)	4,133	4,260
2	Cost of energy purchased (Rs. Crore)	2,179	2,191
3	Weighted Avg. Rate of energy purchase for peak power (Rs. /kWh)	5.27	5.14

From the above Table, it is observed that, TANGEDCO has purchased the power at Rs. 5.27/kWh during CY 2017 and Rs. 5.14/kWh during CY 2018 for meeting the peak power requirement.

## 4.2 Options for meeting Peak Power purchase cost

### 4.2.1 Recovery towards Peak Power as per TOD Framework

As discussed in earlier Section, all consumer categories contributed towards peak demand. However, the present Time of Day Framework levies additional charge of 20% during peak period for HT Industry only. Based on the data submitted by

TANGEDCO, the amount recovered from HT Industry by levy of additional charge during peak period is Rs. 763 Crore during CY 2017 and Rs. 737 Crore during CY 2018. The computation of the same is given in the following Table:

*Table 22: Amount recovered from ToD Tariff*

Sr. No.	Particulars	CY 2017	CY 2018
1	Total Consumption for HT Industry (MU)	24,611.42	23,512.29
2	Consumption of HT Industry during Morning and Evening Peak period (MU)	6005.02	5805.61
3	Normal Energy Charges (Rs. /kWh)	6.35	6.35
4	Normal Energy Charges during Morning and Evening Peak period (Rs. Crore) (A)	3,813.19	3,686.56
5	Energy Charges as per TOD Framework (Rs. /kWh)	7.62	7.62
6	Energy Charges during Morning and Evening Peak period as per TOD framework (Rs. Crore) (B)	4,575.83	4,423.87
7	<b>Additional Energy Charges recovered as per TOD Framework (B-A)</b>	<b>762.64</b>	<b>737.31</b>

Also, a rebate of 5% is given during off-peak period. A rebate of Rs. 219 Crore in CY 2017 and Rs. 211 Crore in CY 2018 has been payable during Off-peak period as shown in the following Table:

*Table 23: Rebate as per ToD Tariff for CY 2017 and CY 2018*

Sr. No.	Particulars	CY 2017	CY 2018
1	Total Consumption for HT Industry (MU)	24,611.42	23,512.29
2	Consumption of HT Industry during Off-Peak period (MU)	6,903.82	6,652.70
3	Normal Energy Charges (Rs. /kWh)	6.35	6.35
4	Normal Energy Charges during Off-Peak period (Rs. Crore) (A)	4,383.93	4,224.46
5	Energy Charges as per TOD Framework (Rs. /kWh)	6.03	6.03
6	Energy Charges as per TOD Framework (Rs. Crore) (B)	4,164.73	4,013.24
7	<b>Energy Charges payable to consumers as per TOD Framework (A-B)</b>	<b>219.20</b>	<b>211.22</b>

From the above analysis, the following observations have been made:

- (a) The cost of peak power purchase is calculated as Rs. 2,179 Crore for CY 2017 and Rs. 2,191 Crore for CY 2018.
- (b) After levying additional 20% of energy charges during peak period, the amount of energy charges recoverable during peak period is Rs. 763 Crore for CY 2017 and Rs. 737 Crore for CY 2018, which is much lower than the cost of peak power purchase.
- (c) The levy of additional 20% of energy charges, as per present framework, enables recovery of only 34% of cost of peak power purchase.
- (d) If rebate given during Off-peak period is adjusted against the additional 20% of energy charges, net additional energy charges recoverable are Rs. 543 Crore for CY 2017 and Rs. 526 Crore for CY 2018, which is only around 24% of cost of peak power purchase.

From the above observations, it is clear that, as per present applicable TOD tariff, there is significant under-recovery of cost of power purchase for peak period. Hence, there is need to either increase the TOD tariff or extend the applicability to other consumer categories, or both.

#### **4.2.2 Options for meeting Peak Power purchase cost**

The present TOD framework leads to shortfall in recovery of cost of peak power purchase. The limited applicability of TOD tariff to only one category, limits the recovery of cost of peak power through levy of additional energy charges.

In order to mitigate this gap, one option is to increase energy charges during peak period for HT Industry category, so that it would lead to increase in recovery of cost of peak power purchase. Second option is to levy TOD tariff to other HT categories and selected LT categories.

If the first option is exercised, an additional 59.43% of energy charge is required to be levied for full recovery of cost of power purchase during peak period. This means that peak energy charges would increase to Rs. 10.12/kWh from present level of Rs.

7.62/kWh, considering no revision in tariff. This will lead to substantial increase in tariff, i.e., Rs. 2.50/kWh for HT Industry during peak period.

If the second option is exercised and TOD Tariff is made applicable to other HT categories, then there would be additional recovery of Rs. 65.97 Crore during peak period. This comprises recovery of Rs. 5.24 Crore from HT Commercial, Rs. 59.39 Crore from Railways and Rs. 1.34 Crore from remaining HT categories. The major contribution would come from Railways. However, TOD tariff is not applicable to Railways in any of the States except Delhi and Orissa.

In case of Delhi, Railway Traction load has been clubbed under a new category namely Public Utilities Category, which includes Jal Board and Public Lighting consumers, and TOD tariffs have been made applicable to all categories except Domestic with a sanctioned load of 10 kW.

In case of Orissa, Railway Traction is a separate category and TOD rebate during off-peak hours is applicable to all consumer categories with three-phase connection except Public Lighting and Emergency supply to Captive Power Plants.

One can think of TOD tariff to be made applicable to Railways. However, the main objective of TOD tariff is Demand Side Management, i.e., consumer should be encouraged to shift load from peak periods to normal or off-peak periods. In case of Railways, the major load is traction load, arising out of moving trains. There is no possibility of shifting of load by Railways as schedule of Railways cannot be changed as per the pattern of electricity consumption. Hence, it would not be appropriate to levy TOD Tariff to Railways.

In Uttar Pradesh, ToD tariffs are made applicable to street light consumption. It is apparent that street light consumption occurs during evening peak and off-peak hours of the night. It is not possible to shift the load of evening peak of street lighting to off-peak hours and hence, it is not appropriate to levy ToD tariff for street lighting.

In light of the foregoing, it is required to exercise both options, i.e., to increase limit of levy of additional energy charge during peak period and to make TOD tariff applicable to other HT categories except Railways and Temporary.

Also, LT categories have significant contribution in total demand of TANGEDCO. As discussed in earlier Chapter of this Report, in many States, TOD tariff has also been made applicable to LT Commercial and LT Industrial categories. Similar approach may be taken for TANGEDCO, and TOD tariff can be made applicable to LT Commercial and LT Industrial consumers. As this will lead to significant capital expenditure towards installation of TOD meters, initially, TOD tariff may be made applicable for LT Commercial and LT Industrial consumers already having meters with demand recording facility. Accordingly, LT Commercial and LT Industrial consumers having load above 25 HP may be considered for applicability of TOD tariff, initially, and the TOD tariffs can be extended to other LT Commercial and LT Industrial consumers subsequently.

The increase of tariff during peak period to 25% of energy charges would generate additional revenue of Rs. 192.31 Crore. The rebate of 5% during off-peak hours available presently may be continued, as withdrawal of the same may result in consumers shifting their consumption to other hours, which may adversely affect the load curve.

**Hence, it is recommended to increase the levy of additional energy charge to 25% from the present level of 20%. Also, TOD Tariff to be made applicable to all HT categories (except Railways and Temporary), LT Commercial (for consumer having load above 25 HP) and LT Industrial (for consumer having load above 25 HP). The rebate of 5% during off-peak hours may be continued.**

## 5 Recommendations and Conclusion

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### 5.1 Proposal for Time of Day Tariff Structure

- 1) Based on the analysis of Load Curves, the following slots are proposed for Time of Day Tariff:
  - a) 22:00 Hrs to 05:00 Hrs – Off-peak Period
  - b) 05:00 Hrs to 06:30 Hrs – Normal Period
  - c) 06:30 Hrs to 10:30 Hrs – Morning Peak Period
  - d) 10:30 Hrs to 18:00 Hrs – Normal Hours
  - e) 18:00 Hrs to 22:00 Hrs Evening Peak Period
- 2) It is proposed that ToD Tariff for peak and off-peak may be determined for two different seasons, viz., Season 1 – March to July and Season 2 – August to February, since the demand pattern is different.
- 3) In Season 1, the evening peak is significantly higher than the morning peak and therefore, the charges for evening peak hours may be higher as compared to the morning peak hours, unlike the existing tariff structure where the peak period charges are same for morning peak hours as well as evening peak hours.
- 4) It is proposed that the ToD tariff may be same for morning peak and evening peak for Season-2.
- 5) It is recommended to increase the limit of levy of additional energy charge to 25%.
- 6) TOD Tariff to be made applicable to all HT categories (except Railways and Temporary), LT Commercial (for consumer having load above 25 HP), and LT Industrial (for consumer having load above 25 HP).
- 7) The rebate of 5% during off-peak hours may be continued.

### 5.2 Regulatory Process for Approval of ToD

The proposed ToD charges in the above section is for the next Control Period from FY 2019-20 to FY 2021-22. TANGEDCO should file Tariff Petition for the next Control Period and the proposal for ToD tariff as discussed in this Report may be proposed



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along with the Tariff Petition and the report may be submitted to the Commission in the form of an Annexure to the Tariff Petition.