PricewaterhouseCoopers India Private Limited
Regulatory Economics Advisory

0

# Assignment on Implementation & Impact Analysis of Time of Day (TOD) tariff in India

Final report

πωγ

# Table of contents

## 1. Introduction

Time of Day (TOD) tariff, is recognized globally across electricity industries, as an important Demand Side Management (DSM) measure which is used as a means of incentivizing consumers to shift a portion of their loads from peak times to off-peak times, thereby improving the system load factor by reducing the demand on the system during peak period.

The TOD tariffs send price signals to consumers that reflect the underlying cost of generating, transmitting and supplying electricity, and enables resources to be allocated more judiciously and efficiently. Further price based demand response can reduce or shape consumer demand particularly to reduce load at peak hours on the electricity system. Hence, TOD tariff assumes importance in the context of propagating and implementing DSM and achieving energy efficiency in the country.

There are a number of ways to incentivise demand reduction and energy conservation, which includes:

- Tariffs
- Technology
- Quotas
- Customer education etc

DSM programs that lay emphasis on tariffs primarily aim at introducing a negative slope in the demand curve in order to let demand and supply balance out at a reasonable price of electricity during tight demand-supply conditions.

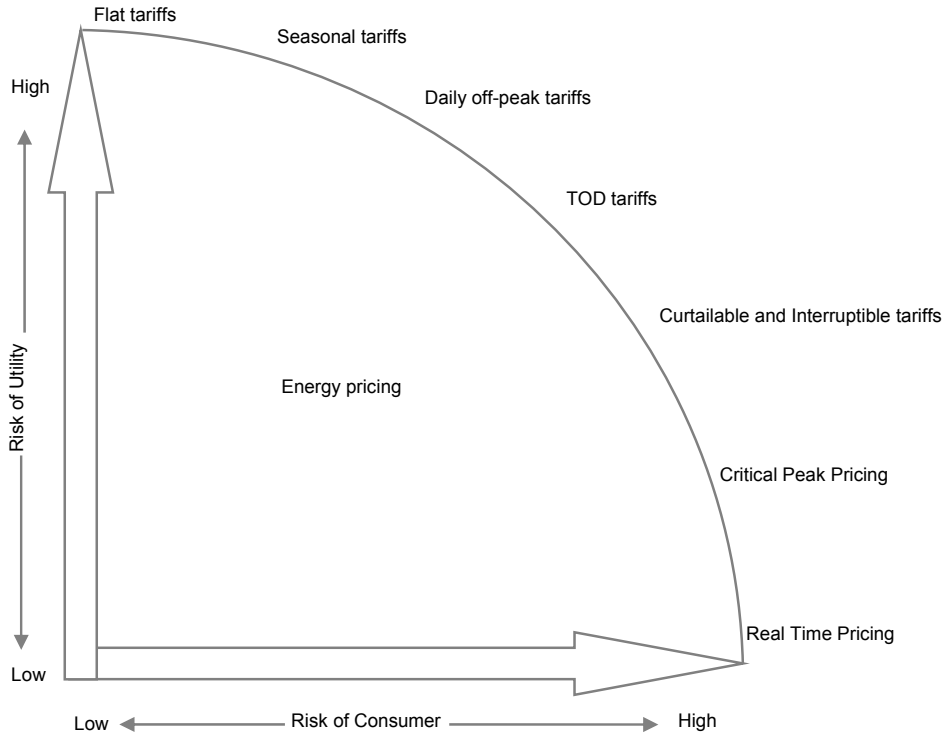
The programs involving demand response to tariffs, designed to relieve peak system capacity constraints, generally fall into either of the two categories:

- Load curtailment programs which pay the customer for reducing peak load during critical times; and
- Dynamic pricing programs which give customers an incentive to lower peak loads in order to reduce their electricity bills.

Dynamic tariffs are designed to lower the system costs for utilities and bring down consumers' bills by increasing tariffs during peak hours and lowering them during off-peak hours. The load shape objective is to reduce peak loads and/or shift load from peak to off-peak periods. Various dynamic pricing tariffs have been developed, which include:

- Time-of-Day Tariffs (TOD): This tariff design features electricity tariffs that vary by time period, being higher in peak periods and lower in off-peak period. The simplest TOD tariff can be structured as a two period tariff, a peak period and an off-peak period.
- Critical Peak Pricing (CPP): This tariff design features a much higher critical peak tariff in addition to TOD tariffs. The CPP is only used on a maximum number of days each year, the timing of which is unknown until a day ahead or perhaps even the day of a critical pricing day
- Extreme Day Pricing (EDP): This tariff design is similar to CPP, except that the higher price is in effect for all 24 hours for a maximum number of critical days, the timing of which is unknown until a day ahead.
- Extreme Day CPP (ED-CPP): This tariff design is a variation of CPP in which the critical peak price and correspondingly lower off-peak price applies to the critical peak hours on extreme days but there is no TOD tariff on other days.
- Real Time Pricing (RTP): This tariff design features electricity tariffs that vary hourly or sub-hourly all year long, for some or a customer's entire load. Customers are notified of the rates on a day-ahead or hour-ahead basis.

The differing dynamic pricing tariffs as discussed above exposes consumers and utilities to the varying amounts of risk shown below:




The extent to which TOD tariffs can be fully implemented depends on the customer that is being served, i.e. the practicality of implementation and the consumer's ability to respond to the pricing signal. Any TOD tariff introduced on its own to promote efficiency will not be successful if it does not take into consideration the customer's perspective. A pricing signal might have to be complex to provide the required economically efficient behavior, but if in practice it cannot be measured because the cost of metering is not financially viable, such a pricing signal might not achieve the desired purpose. Further, if a consumer cannot respond to the pricing signal, the pricing signal again may not achieve its desired purpose. This typically happens where the customer's usage is very low and therefore the customer has no ability to shift or reduce load, or the customer has a fixed consumption of energy every day.

Besides being a DSM measure another important objective of the TOD tariff particularly in the context of peak demand deficit scenario in our country is that the introduction of TOD tariff will help in developing pricing mechanism for setting up of generation plants which could meet the system peaking power requirements.

### Framework for implementation of TOD tariff

Various legislative and legal frameworks existing in the country which promote implementation of TOD as an important DSM tool are:

### Electricity Act

The relevant provision of Section 62(3) of the Act which guides the SERCs to incorporate TOD tariff is:
*"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."*

### National Tariff Policy

The relevant provisions of the National Tariff Policy, which define the tariff components and their applicability states as under:
*"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."*

### National Electricity Policy

The relevant provision of the National Electricity Policy with respect to encouraging metering for TOD is:
*"5.4.9 The Act required 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".*

### FOR recommendations

FOR has also 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."*

### CEA regulations

Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006 have stated the following with respect TOD metering:

*"20.Adoption of new technologies -*
*The distribution licensee shall make out a plan for introduction and adoption of new technologies such as pre-paid meters, time of the day meters (TOD), automatic remote meter reading system through appropriate communication system with the approval of the Appropriate Commission or as per the regulations or directions of the Appropriate Commission or pursuant to the reforms programme of the Appropriate Government."*

### Objective of the report

This report has been prepared as a part of the study "Assignment on Implementation & Impact Analysis of Time of Day (TOD) tariff in India" which was awarded by Forum of Regulators (FOR) to M/s PricewaterhouseCoopers Private Limited.

The report also incorporates the directives of the 18$^{th}$ Meeting of FOR held at Delhi on 30$^{th}$ July, 2010, on the draft report presentation.

The report has been structured into the following chapters:

Chapter 1: Introduction

Chapter 2: This chapter features analysis of the implementation of Time of Day tariff in different states in the country including analysis of the approach of the State Electricity Regulatory Commissions (SERCs) in implementing Time of Day tariff.

Chapter 3: This chapter features the framework for undertaking impact analysis of TOD tariff and impact analysis of the TOD tariff in selected five states (chosen in consultation with FOR Secretariat) based on the data submitted by the utilities.

Chapter 4: This chapter covers the cost of TOD metering based on the data submitted by the utilities and the framework for undertaking cost-benefit analysis of implementing TOD tariff for the utilities.

Chapter 5: This chapter features recommendation and way forward for implementation of TOD tariff.

## 2. Review of TOD implementation in states

Most of the State Electricity Regulatory Commissions (SERCs) have implemented TOD tariffs, generally for large industrial and commercial category consumers in the country. The status of TOD implementation across various states is tabulated as under:

| S. No. | State | TOD implemented |
|---|---|---|
| 1 | Assam | Yes |
| 2 | Bihar | Yes |
| 3 | Chhattisgarh | Yes |
| 4 | Gujarat | Yes |
| 5 | Himachal Pradesh | Yes |
| 6 | Jharkhand | Yes |
| 7 | Karnataka | Yes |
| 8 | Kerala | Yes |
| 9 | Madhya Pradesh | Yes |
| 10 | Maharashtra | Yes |
| 11 | Orissa | Yes |
| 12 | Tamil Nadu | Yes |
| 13 | Tripura | Yes |
| 14 | Uttarakhand | Yes |
| 15 | Uttar Pradesh | Yes |
| 16 | West Bengal | Yes |
| 17 | Andhra Pradesh | Yes |
| 18 | Delhi | - |
| 19 | Haryana | - |
| 20 | Jammu & Kashmir | - |
| 21 | Punjab | - |
| 22 | Rajasthan | - |
| 23 | Manipur | - |
| 24 | Meghalaya | - |
| 25 | Arunachal Pradesh | - |

The section below presents the status of TOD tariffs as implemented in various states of the country. The analysis is primarily based on the tariff orders issued by SERCs.

The analysis has been done covering the following salient aspects:

- Introduction of TOD and consumer categories covered;
- Rationale for introduction of TOD; and
- Rate difference in peak hours, normal hours and off-peak hours.

**Assam**

The Commission had introduced TOD in its first tariff order of FY 2004-05, itself. In the order the Commission states that it has studied a typical load curve of ASEB and found that the utility has a single peak during evening and otherwise there is no difference between night and day load. The purpose of introducing TOD tariff is to flatten the load curve.

The Commission had in its tariff order for FY2005-06 outlined its approach on TOD tariff, stated as under:-
*"It is well recognized that there is a variation in the costs of the power procured at different times of the day and at different seasons. Further, it is also recognized that costs of the power delivered would be different depending upon the nature of usage and the class of consumers too. Network costs involved (for the delivery of power) would also be different for different consumers. Hence prudently, in the scenario of a full cost recovery, the consumers should be charged a tariff that recovers the costs he is responsible for. TOD and Seasonal Tariffs are manifestations of this principle as is the difference in fixed charges and Energy charges for different categories of consumers. In the near future the Commission would like the licensees to conduct a study to voltage based cost of supply that would indicate the actual cost of supply to particular consumer categories and file it separately to the Commission. This study would also be critical in the determination of cross subsidy between categories."*

The TOD tariff presently applicable in the state is tabulated as under:

| Particulars | HT– I Industries | HT-II Industries (Applicable to consumers who exercise Option-1) | HT-VI: Tea, Coffee & rubber | HT- VII: Oil and Coal |
|---|---|---|---|---|
| **Applicable energy charges** | 3.75 Rs/ kWh | 3.85 Rs/ kWh | 4.20 Rs/ kWh | 4.25 Rs/ kWh |
| **Time of Day** | | | | |
| 22.00 Hrs to 06.00 Hrs (night) | 3.10 Rs/ kWh | 3.35 Rs/ kWh | 3.95 Rs/ kWh | 4.10 Rs/ kWh |
| 06.00 Hrs to 17.00 hrs (normal) | 3.75 Rs/ kWh | 3.85 Rs/ kWh | 4.20 Rs/ kWh | 4.25 Rs/ kWh |
| 17.00 Hrs to 22.00 Hrs (peak) | 6.00 Rs/ kWh | 5.30 Rs/ kWh | 6.00 Rs/ kWh | 6.00 Rs/ kWh |

*Source: Tariff Order FY 2008-09 and 2009-10*

The Commission in the Tariff order for FY08-09 & FY09-10 has also commented w.r.t the data provided by the Discoms on the TOD:

Three Tier TOD Tariff has been effective with almost all the categories shifting their evening consumption to other periods of the day;

The 83 MW consumed by categories (covered under TOD) during the evening is almost comparable to the 100-150 MW average shortage of peak power during the year;

The peak consumption may be reduced further by enhancing the T.O.D. rates during evening period in the subsequent tariffs. Otherwise, the DISCOMs may also resort to forced load shedding wherever possible and save themselves from buying power from outside sources at very high rates;

Also, the DISCOMs and these consumers may enter into an agreement to use their captive plants during the evening hours and an incentive scheme may be designed for the consumers to suit both parties. There is scope for further analysis on the above matter.

**Bihar**

The Commission in tariff order of FY 2008-09 has provided optional TOD tariff for all HT consumers other than Railway traction.

The categories of consumers covered under HT supply are as under:

- HTS-I (11kV/6.6kV): Applicable for supply for use in installations with a minimum contract demand of 75 kVA and maximum contract demand of 1500 kVA.
- HTS-II (33kV): Applicable for use in installations with a minimum contract demand of 1000 kVA and maximum contract demand of 10,000 kVA.
- HTS-III (132 kV): Applicable for installations with a minimum contract demand of 7.5 MVA.
- HTSS (33kV/11kV): Applicable for supply of electricity to all consumers who have contract demand of 300 kVA and more for induction furnace loads, but will not apply to castings units having induction furnace of melting capacity of 500 Kg and below.

The maximum demand and consumption recorded in different periods is billed at the following TOD rates on the base tariff applicable to the consumer.

| Time of use | Applicable rates |
|---|---|
| Normal period ( 5:00 AM – 5:00 PM ) | Normal rate of energy charge |
| Evening peak load period ( 5:00 PM- 11.00 PM) | 120% of normal rate of energy charge |
| Off-peak load period (11:00 PM- 5:00 AM) | 90% of normal rate of energy charge |

*Source: Tariff Order FY 2008-09*

Applicability and terms and conditions of TOD tariff specified by the Commission in the Tariff Order for FY 2008-09 are listed as under:

- TOD tariff is optional for all HT industries;
- The facility of aforesaid TOD tariff is not available to HT consumers having captive power plants and/or availing supply from other source through wheeling of power;
- The HT industrial consumers who have installed standby generating plants are also eligible for the aforesaid TOD tariff;
- After electing TOD tariff, if any industrial HT consumer on account of some reasons wants to go back to the earlier tariff according to the agreement, this facility is available to him only once in two years;
- If the actual monthly consumption of such HT consumer, whose monthly minimum charges are based on units, is less than minimum consumption, then the difference (deficit) of units between the minimum consumption and actual consumption is billed at normal rate of energy charge prescribed for “Normal Period”;
- In case, the consumer exceeds 110% of the contract demand, the demand in excess of contract demand is billed at twice the normal tariff applicable for the day time i.e. 5:00 a.m. to 5.00 p.m. irrespective of the time of use.

Load factor rebate is also given to all HT consumers except Railway traction for higher consumption only on the excess units consumed.

### Chhattisgarh

Time of Day tariff was included even in the first tariff order passed by the regulator for FY 2005-06. As Chhattisgarh was part of Madhya Pradesh earlier, TOD tariff notified in Madhya Pradesh were applicable in the state before this tariff order.

Under the TOD tariff, maximum demand and consumption recorded in different periods is billed at the following rates on the tariff applicable to the consumer:

| Particulars | Tariff applicable |
|---|---|
| *Demand Charges* | Normal rate of Demand Charge |
| Plus | Plus |
| *Energy Charge* | |
| Period of energy consumption | |
| • Normal peak period (05:00 AM to 6:00 PM) | Normal rate of energy charges |
| • Evening peak load period ( 6:00 PM to 11:00 PM) | 130% of Normal rate of energy charge |
| • Off-peak load period (11:00 PM to 05:00 AM of next day) | 85% of Normal rate of energy charge |

*Source: Tariff Order FY10*

#### Applicability and Terms & Conditions of TOD tariff

TOD tariff is applicable to all EHV and HV industries covered in EHV-2, EHV- 3, EHV-4, HV-1, HV-2 and HV-3 categories.

In case, the consumer exceeds the contract demand, the demand in excess and the corresponding energy is billed at one and a half times of the normal tariff applicable for the day time (i.e. 5:00 a.m. to 6:00 p.m.) irrespective of the time of usage.

### Gujarat

Time of Use tariff is mentioned in the state right from the first tariff order FY1999-2000. As per the latest tariff order issued by the Commission, Time of Use tariff is applicable as under:

- Time of Use Discount is applicable to all the Water Works consumers having connected load of 50 HP and above for the energy consumption during the Off-Peak load hours of the day specified as under:

| Particulars | Applicable Discount |
|---|---|
| For energy consumption during the off-peak period, viz., 1100 Hrs to 1800 Hrs. | 30 paise per unit |
| For energy consumption during night hours, viz., 2200 Hrs to 0600 Hrs. next day | 75 paise per unit |

- Time of Use charges is levied from HTP-I consumers (HT consumers contracted for 100 kVA and above for regular power supply and includes Water Works and Sewerage pumping stations run by Local Authorities and GW & SB, GIDC Water Works, R&D units) having contract demand or actual demand of 500 kVA and above shown as under:

| Particulars | Applicable Tariff |
|---|---|
| Demand Charges + Energy Charges | |
| Plus | |
| TOU charges | |
| For energy consumption during the two peak periods, viz., 0700 Hrs to 1100 Hrs and 1800 Hrs to 2200 Hrs | 75 paise per unit |

- Concession for Use of Electricity during Night Hours: For the HTP-I consumers eligible for using supply at any time during 24 hours, entire consumption is billed at the specified energy charges. However, the energy consumed during night hours of 10.00 PM to 06.00 AM next morning (recorded by a polyphase meter operated through time-switch) as is in excess of one third of the total energy consumed during the month, is eligible for concession at the rate of 75 Paise per unit. The polyphase meter and time switch is to be procured and installed by the consumer at his cost and sealed by the Distribution Licensee.
- For supply of energy to HTP-II (A) consumer category (HT consumers contracting for 100 KVA and above, requiring power supply for Railways, hotels, amusement parks, resorts, water parks, aerodromes, cinemas, auditoriums, banks, studios, offices, film production, etc., requiring and given separate point of supply and such other establishments) the Time of Use charges as applicable from such a consumer having contract demand or actual demand of 500 kVA and above are shown below:

| Particulars | Applicable Tariff |
|---|---|
| Demand Charges + Energy Charges | |
| Plus | |
| TOU charges | |
| For energy consumption during the two peak periods, viz., 0700 Hrs to 1100 Hrs and 1800 Hrs to 2200 Hrs | 75 paise per unit |

- For supply of energy to HTP-II (B) consumers (HT consumers contracting for 100 kVA and above, requiring power supply for residential colonies, townships, educational institutions governed by the government, and Defence Establishments) the Time of Use charges as applicable from such a consumer having contract demand or actual demand of 500 kVA and above are as shown for HTP-II (A) consumers.
- For supply of energy to HTP-III consumers who are taking supply of electricity at high voltage, contracting for not less than 100 kVA for temporary period, the Time of Use charges applicable are as shown for HTP-II (A) consumers

**Himachal Pradesh**

TOD tariff was introduced in the state in FY 2001-02. It is implemented for Industries and Water Pumping Supply with connected load more than 20 kW.

In addition to TOD tariff, Peak Load Exemption Charge (PLEC) of Rs 50/KVA/Month is also applicable and in case demand exceeds PLEC during peak hours there is also additional charge which is levied termed as Peak Load Violation Charge (PLVC).

The time period for applicability of TOD tariff is as under:

- Peak hours: 7 :00 PM – 10:00 PM in Summer (Apr - Oct) and 6.30 pm - 9.30 pm in Winter (Nov - March)
- Off-peak hours: 12:00 AM – 6:00 AM

Concession in energy charges for Off-peak hour is given @ of 20 paise/unit. Additional energy charges applicable for Peak hour consumption are 100% of normal electricity charges.

**Jharkhand**

The Commission had introduced TOD tariffs only for HTS-I, HTS-II and EHTS consumers in the Tariff order for FY 2003-04.

Rationale for introduction of TOD tariffs

The Commission had introduced TOD tariffs with the following stated rationale in tariff order for FY 2003-04:

*"Higher demand during morning and evening hours is a typical characteristic of a load curve. Such higher demand is typically met through peaking stations, which are generally more expensive as compared to the base load stations. The higher cost of supply during the peak load hours is reflected through a time of day tariff in the tariff structure. Such a tariff structure provides correct signals to the consumers and also helps the utility to maintain a better system profile. Time of use charge attracts consumers to transfer daytime load to night time and thereby improves the system load factor."*

Section 15.2.6 of the industrial policy announced by the Government of Jharkhand in 2001 also suggested a two-tier system of electricity tariffs to be charged from the industrial consumers.
*"The Commission also feels that there is a need to incentivise off-peak consumption, while at the same time disincentivise peak hour consumption, so that consumers are motivated to shift from peak to off peak hours. On the basis of above discussion it is evident that it would be rational to apply a TOD charge for consumption during the peak load hours and a rebate during off peak hours, which should be a part of the tariff structure. Ideally, such a tariff should be available to all consumers. The Commission, however, recognizes that certain issues like availability of data on time of day consumption, installation of meters with the requisite facility to record time differentiated consumption, determination of peak and off peak hours and tariff and providing enough incentives to consumers to make use of this tariff will need to be addressed before this tariff becomes fully operational in the state. Therefore, the Commission has introduced TOD tariffs only for HTS-I, HTS-II and EHTS consumers, where, in accordance with the industrial policy, the TOD meters have to be installed by the industrial units at their own cost."*

The Commission had asked Jharkhand State Electricity Board (JSEB) to conduct sample studies to collect and compile information on the demand from various consumer categories at different times of the day as well as on consumption of energy during these intervals as part of the load research study in order to design more rational TOD tariff, but the Board has not supplied any information in this respect to the Commission.

High Tension Service (HTS): The tariff for this category as per Tariff Order for FY 2003-04, which also included HTS-I, HTS-II, EHTS, was applicable to consumers having contract demand above 100 kVA.

| Description | Tariff |
|---|---|
| Demand charge (Rs/kVA/month) | 140 |
| Energy charge (Rs/ kWh) | 4.00 |
| Monthly Minimum Charge | |
| • For supply at 11kV & 33kV (Rs./kVA) | 250 |
| • For supply at 132 kV (Rs./kVA) | 400 |
| Voltage rebate | |
| • Supply at 33 kV | 5% |
| • Supply at 132 kV | 7.5% |
| Load factor rebate | |
| • Above 40-60% | 5% |
| • Above 60-70% | 7.5% |
| • 70% and above | 10% |
| TOD Tariff (Rs./kWh/ month) | |
| Peak Hour | 4.60 |

| Description | Tariff |
|---|---|
| • 0600 AM- 1000 AM<br>• 0600 PM-1000 PM | |
| Off Peak Hour<br>• 1000 PM- 0600 AM<br>• 1000 AM- 0600 PM | 3.60 |

As per the latest provisional Tariff Order of FY 2010-11 for JSEB, TOD tariff is applicable in the state to the following categories of consumers:

- High Tension Service (HTS): The tariff for this category is applicable to consumers having contract demand above 100 kVA.

| Description | Tariff |
|---|---|
| Demand charge (Rs/kVA/month) | 165 |
| Energy charge (Rs/ kWh) | 4.35 |
| Voltage rebate* | |
| • Supply at 33 kV | 3% |
| • Supply at 132 kV | 5.0% |
| • Supply at 220 kV | 5.50% |
| • Supply at 440kV | 6.0% |
| Load factor rebate* | |
| • Above 40-60% | NIL |
| • Above 60-70% | 7.5% |
| • 70% and above | 10% |
| OPTIONAL TOD Tariff (Rs/kWh/ month) | |
| Peak Hour<br>• 0600 AM- 1000 AM<br>• 0600 PM-1000 PM | 120% of normal rate of energy charge |
| Off Peak Hour<br>• 1000 PM- 0600 AM | 85% of normal rate of energy charge |

**Above rebate will be available only on monthly basis and consumer with arrears shall not be eligible for the above rebates.*

However in case of consumers served by Tata Steel (distribution licensee for Jamshedpur), as per the latest Tariff Order for FY 2005-06, the TOD tariff has not been introduced.

The Commission has directed Tata Steel to collect information on the demand from various consumer categories at different times of the day as well as on consumption of energy during these intervals.-

*An average daily, weekly and monthly load profile over 24 hours of a day may be generated from the above data so that an appropriate 'Time of use' (ToU) based tariff can be formulated*.
Tata Steel has also been asked to undertake a study to estimate the cost implications of metering at sub-station level and consumer level to be able to effectively implement ToU tariff regime which would facilitate design of a rational ToU charge and based on this, the Commission would take a view in the next tariff order.

### Karnataka

TOD tariff was introduced in the state in FY 2005-06, following the recommendations of FOR.

The Commission invited proposals for TOD tariff from the licensees and other stakeholders in May 2005. In response, KPTCL had submitted that as per a study, load curve is almost flat for the state except during evening peak, which means much relief is not anticipated by introducing TOD tariff.

The Commission decided to introduce optional TOD tariff applicable to consumers under LT (wherever trivector meter is fixed), HT industrial categories and HT water supply.

Details of TOD tariff applicable in the state are shown as under:

| Particulars | LT 5(b) consumer category | HT 1 water supply & sewage | HT 2a (i) & (ii) consumer category |
|---|---|---|---|
| **Applicable energy charges** | | 350 paise/unit | 430 – 460 paise/unit |
| For the first 500 units | 330 paise/ unit | | |
| For the next 500 units | 390 paise/ unit | | |
| For the balance units | 425 paise/unit | | |
| **Time of Day** | | | |
| 22.00 Hrs to 06.00 Hrs | -80 paise/ unit | -60 paise/ unit | -80 paise/ unit |
| 06.00 Hrs to 18.00 hrs | 0 | 0 | 0 |
| 18.00 Hrs to 22.00 Hrs | +80 paise/ unit | +60 paise/ unit | +80 paise/ unit |

*Source: Tariff Order FY10*

### Kerala

Kerala State Electricity Board had implemented the differential pricing for EHT consumers from 1998 and for HT consumers from 2002 by introducing TOD meters.

The Commission in December 2009 revised the TOD tariff applicable to HT-EHT consumers from January 2010 in the state, shown as under:

| Particulars | Normal period (06:00 hrs to 18:00 hrs) | Peak period (1800 hrs to 2200 hrs) | Off-peak (2200 hrs to 0600 hrs) |
|---|---|---|---|
| **Demand charges** | 100% | 140% | 80% |
| **Energy charges** | 100% | 130% | 85% |

### Maharashtra

MERC introduced TOD tariff in Maharashtra in FY 2000-01. The Commission had in the matter of "Revision of tariff applicable to various categories of consumers of Maharashtra State Electricity

Board with effect from 01.05.2000" issued an Order dated April 28, 2000 wherein the Commission had prescribed as under:

*"The Commission has introduced the Time of Day (TOD) tariff for HT industrial (HTP - I & HTP - II) consumers. The Commission intends to use the TOD tariff as a critical tool for Demand Side Management. The Commission expects HT industrial consumers to avail of this facility by shifting consumption from peak period to off peak period. This will not only benefit the industrial consumers but also help the MSEB in flattening the load curve.*

*The Commission has decided to give incentive to all HTP-I and HTP-II consumers availing of TOD tariff and having power factor above 0.95 by providing a rebate of 1% of the energy bill for every 1% improvement in the power factor."*

Further, the Commission in the matter of determination of tariff applicable to various categories of consumers of the Maharashtra State Electricity Board in Case No.1 of 1999 under Para 1.38 "Optimization of MSEB's Generation", has stated as under:

*"Due to this pattern of use, there are times in the evening and before noon, when activity level in the society is high, and the demand for electricity increases compared to other times of the day. Against this, in the night (10 pm to 6 am), the sleeping hours require a low demand for electricity. Therefore, many power stations are required to be closed or operated at lower capacity.*

*The tariff should give incentive for shifting demand to lean period and penalize in peak period. Further the load factor (KWH per KW of demand) also needs to be improved. This can be done either by load factor incentive or through rational demand charges. Hence, the Commission provides for Time of Day tariff (TOD) and also rationalizes, Demand charges for High Tension Industrial consumers (HTP I and II categories) The Commission expects a shift and reduction in the HT industrial demand by about 250 to 500 MW. This should improve the PLF of the MSEB's thermal power stations by 2 to 4 percentage points (still lower than plant availability). Though there will be a reduction in Demand charge revenue, the net gain will be higher on account of lesser load -shedding /lesser purchase of expensive power/lesser backing-down and also additional revenue earned by sale of additional units during the night lean period."*

The TOD tariff set in the order dated 28.04.2000 for the year FY2000-01 is shown in the table below:

| Category of consumers | Demand charge (Rs/kVA/month) | Energy Charge (paise/unit) |
|---|---|---|
| **HTP-I (Industrial – BMR/PMR)** | | |
| Base Tariff | 300 | 335 |
| TOD tariff | | |
| • 2200 hrs- 0600 hrs | 0 | -50 |
| • 0600 hrs-0900 hrs | 0 | 0 |
| • 0900 hrs-1200 hrs | 0 | 30 |
| • 1200 hrs- 1800 hrs | 0 | 0 |
| • 1800 hrs-2200 hrs | 0 | 60 |
| | | |
| **HTP-II (Industrial – Others)** | | |
| Base Tariff | 280 | 325 |
| TOD Tariff | | |

| Category of consumers | Demand charge (Rs/kVA/month) | Energy Charge (paise/unit) |
|---|---|---|
| • 2200 hrs- 0600 hrs | 0 | -50 |
| • 0600 hrs-0900 hrs | 0 | 0 |
| • 0900 hrs-1200 hrs | 0 | 30 |
| • 1200 hrs- 1800 hrs | 0 | 0 |
| • 1800 hrs-2200 hrs | 0 | 60 |

The Commission in the Tariff Order of MSEDCL for FY 2009-10 has specified the following with respect to the TOD tariffs:
*"As regards MSEDCL's proposal to remove the rebate given for ToD consumption during night off-peak hours, the Commission is of the view that Time of Day tariffs were introduced as a Demand Side Management measure, to flatten the load curve, and over the years, the tariff differential between peak and off-peak hours has been increased, which has achieved good results."*

The Commission in the Tariff Order for FY 2009-10 has further stated that:
*"most of the load that could have been shifted to off-peak hours would have already shifted. However, if the off-peak rebate during night off-peak hours is removed, then there is a danger of this load shifting either to day off-peak, where there is no penal tariff, or to evening peak hours, where there is peak tariff, depending on the economics of operation of the particular consumer. It should be appreciated that night operations do involve certain hardships for the consumers, and if sufficient incentive is not given/retained, the load may shift to other hours of the day."*

As per the tariff order for FY 2009-10, applicability of TOD tariff and consumer categories is shown below.

The TOD tariffs is applicable compulsorily to HT I, HT II, and HT IV categories among HT categories, and LT II (B), LT II (C), LT III, and LT V (B) category consumers having TOD meters, as well as optionally available to LT – II (A) and LT V (A) category consumers, who have TOD meters. The TOD tariffs applicable are as under:

- Five time slots, viz., (a) 2200 to 0600 hours, (b) 0600 to 0900 hours, (c) 0900 to 1200 hours, (d) 1200 to 1800 hours, and (e) 1800 to 2200 hours.
- Additional peak hour tariff is payable for consumption during the peak hours in the State, viz., 0900 to 1200 hours (morning peak) and 1800 to 2200 hours (evening peak) in the following manner:
  - 0900 to 1200 hours : Additional 0.80 Rs/kWh
  - 1800 to 2200 hours : Additional 1.10 Rs/kWh
  - For consumption during night off-peak hours, viz., 2200 to 0600 hours, a rebate of 0.85 Rs/kWh is available
  - Neither additional tariff nor rebate is applicable for consumption during 0600 to 0900 hours and 1200 to 1800 hours

| S. No. | Consumer Category | Fixed/Demand Charge | Energy Charge (Rs kWh) |
|---|---|---|---|
| 1 | **LT-II : LT Non-residential or Commercial** | | |
| (A) | • 0-20 kW (0-200 units/ month) | Rs 150 per month | 4.20 |

| S. No. | Consumer Category | Fixed/Demand Charge | Energy Charge (Rs kWh) |
|---|---|---|---|
| | • Above 200 units/ month (only balance consumption) | | 5.90 |
| (B) | > 20 kW and ≤ 50 kW | Rs. 150 per kVA per month | 6.20 |
| (C) | > 50 kW | Rs. 150 per kVA per month | 8.10 |
| 2 | **LT-III: Public Water Works & Sewage Treatment Plants** | | |
| (A) | 0-20 kW | Rs. 40 per kVA per month | 1.60 |
| (B) | > 20 kW and ≤ 40 kW | Rs. 50 per kVA per month | 2.10 |
| (C) | > 40 kW and < 50 kW | Rs. 70 per kVA per month | 2.90 |
| 3 | **LT-V: LT Industry** | | |
| (A) | 0-20 kW | Rs. 150 per month | 3.50 |
| (B) | Above 20 kW | Rs. 100 per kVA per month for 65% of maximum demand or 40% of Contract Demand, whichever is higher | 4.75 |
| | TOD Tariffs (in addition to above base tariffs) – compulsory for LT II (B) and (C), LT III, LT V (B), and optional for LT II (A) and LT V (A) category | 0 | -50 |
| | • 0600 hrs- 0900 hrs | | 0.00 |
| | • 0900 hrs- 1200 hrs | | 0.80 |
| | • 1200 hrs- 1800 hrs | | 0.00 |
| | • 1800 hrs- 2200 hrs | | 1.10 |
| | • 2200 hrs – 0600 hrs | | -0.85 |
| | **HT Tariffs** | | |
| 4 | **HT-I Industry** | | |
| (A) | Express feeders | Rs. 150 per kVA per month | 5.05 |
| (B) | Non-express feeders | | 4.60 |
| (C) | Seasonal industry | | 5.70 |
| 5 | **HT-II: Commercial** | Rs. 150 per kVA per month | 7.15 |
| 6 | **HT-III: Railways** | | 5.35 |
| 7 | **HT-IV : Public water works & Sewage Treatment Plants** | | |
| (A) | Express feeders | Rs. 150 per kVA per month | 3.50 |
| (B) | Non-express feeders | | 3.40 |
| 8 | **HT-V: Agriculture** | Rs. 25 per kVA per month | 1.95 |
| 9 | **HT-VI** | | |

| S. No. | Consumer Category | Fixed/Demand Charge | Energy Charge (Rs kWh) |
|---|---|---|---|
| (A) | Group Housing Society | Rs. 125 per kVA per month | 3.60 |
| (B) | Commercial complex | | 6.0 |
| 10 | **HT-VII: Mula Pravara Electric Co-op Society** | Rs. 100 per kVA per month | 2.50 |
| 11 | **HT-VIII: Temporary supply** | Rs. 200 per connection per month | 10.00 |
| | TOD Tariffs (in addition to above base tariffs) for HT I, HT II and HT IV categories | | |
| | • 0600 hrs- 0900 hrs | | 0.00 |
| | • 0900 hrs- 1200 hrs | | 0.80 |
| | • 1200 hrs- 1800 hrs | | 0.00 |
| | • 1800 hrs- 2200 hrs | | 1.10 |
| | • 2200 hrs – 0600 hrs | | -0.85 |

*Source: MSEDCL Tariff Order FY10*

The Commission in its ruling against the removal of load factor incentive as sought by MSEDCL in its petition has stated in the Tariff Order for FY 2009-10 as under:

*"The Commission is of the view that contrary to MSEDCL's submission, the existence of load factor incentive does not incentivise higher consumption per se, rather, it incentivises better utilisation of the contract demand. In order to maximise the load factor incentive, the eligible consumers will have to plan their Contract Demand in such a fashion that they are able to maximise their utilisation of the same, which will eventually result in reducing the burden on MSEDCL's system, as the consumers will shift load to different hours of the day and thus, be able to reduce their Contract Demand. This will also enable MSEDCL to serve a steadier load, rather than a fluctuating one."*

Load factor incentive has been given to the HT-I and HT-II consumers under which such consumers having load factor of over 75% up to 85% are entitled to a rebate of 0.75% on the energy charges for every percentage point increase in load factor from 75% to 85%. Consumers having a load factor over 85 % are entitled to rebate of 1% on the energy charges for every percentage point increase in load factor from 85%. The total rebate under this head is subject to a ceiling of 15% of the energy charges for that consumer.

The Load Factor has been defined as under:

$$\text{Load Factor} = \frac{\text{Consumption during the month in MU}}{\text{Maximum Consumption Possible during the month in MU}}$$

Where,

Maximum consumption possible = Contract Demand (kVA) x Actual Power Factor x (Total no. of hours during the month less planned load shedding hours*)

** Interruption/non-supply to the extent of 60 hours in a 30 day month has been built in the scheme*

In case the billing demand exceeds the contract demand in any particular month, then the load factor incentive is not payable in that month. (The billing demand definition excludes the demand recorded during the non-peak hours i.e. 22:00 hrs to 06:00 hrs and therefore, even if the maximum demand exceeds the contract demand in that duration, load factor incentives are

applicable. However, the consumer would be subjected to the penal charges for exceeding the contract demand and has to pay the applicable penal charges).

**Madhya Pradesh**

Based on the analysis of the past tariff orders (available on the Commission's website) it is observed that TOD tariff has been applicable in the state before FY 2002-03. From the analysis of the Tariff Order for FY 2002-03, it is observed that MPSEB had requested the Commission to abolish the prevailing TOD tariff on account of acute power shortage and the System Load Curve, being generally flat for the most part of the year.

The Commission's approach for the introduction of TOD charges is guided by the following:

- Flattening of the system load curve
- As per sub-section (3) of Section 62 of the Act which provides that the tariff determined by the Commission shall not show undue preference to any consumer of electricity, but may differentiate according to the consumer's load factor, power factor, and total consumption of electricity during any specified period or the time at which supply is required or the geographical position of any area, the nature of supply and the purpose for which the supply is required or paying capacity of category of customers and need for cross subsidization.

As per the Tariff Order for FY 2002-03 the TOD charges were applicable to the following consumer categories:

- HV-3:Cement Factories
- HV-4: Mini Steel Plant(MSP) or MSP with Rolling Mills/Sponge Iron Plants in the same premises
- HV-5: Electro Chemical/ Electro Thermal &132kV Ferro Alloys industries
- HV-6: Ferro Alloy manufacturers
- HV-7: Applicable for supply to distribution licensees, sanction holders under sections 15 and 16 of MP Vidyut Sudhar Adhiniyam, 2000, town ships including townships of industries when such supply is availed separately outside premises of the industry and the establishment like Railway Stations, MES, Offices, Hotels, Hospitals and Institutions, etc. having mixed load.
- HV-8: For consumers (Industries and others) not covered under any other Category
- Seasonal consumers: Includes such seasonal industries/ consumers requiring energy for a minimum period of four months and a maximum period of nine months in a year. Rice mills, sugar mills, ice factories, cold storages, ginning and pressing factories will be normally entitled and the Board can give this facility to any other industry in consultation with the Commission.

For the consumer categories mentioned above TOD charges were applicable for different periods of the day i.e. normal period, peak load and off-peak load period. The maximum demand and the consumption recorded in different periods had to be billed according to the rates below. All such consumers were required to give in writing to MPSEB their option for peak hour use or for Off-peak hour use. Only consumers who opted for Off-peak hour use were entitled for concessional rate of 90% of Normal rate, for use of energy during 10 PM to 6 AM. However, if such a consumer, who had opted for off peak hour consumption, was found using grid energy during peak hours, he was required to pay penal charges shown as under:

TOD Charges:

- For consumers who opt for Peak use:

| Peak/Off-peak Period | Period |
|---|---|
| Demand Charges | Normal rate of Demand Charge |

| Peak/Off-peak Period | Period |
|---|---|
| Plus | |
| Energy Charge | Rate (paise per unit) |
| Period of energy consumption | |
| • Normal peak period (06:00 AM to 5:00 PM) | Normal rate of energy charges |
| • Evening peak load period ( 5:00 PM to 10:00 PM) | 130% of Normal rate of energy charge |
| • Off-peak load period (10:00 PM to 06:00 AM next day) | Normal rate of energy charge |

- For consumers who opt for Off Peak hour use:

| Peak/Off-peak Period | Period |
|---|---|
| Demand Charges | Normal rate of Demand Charge |
| Plus | |
| Energy Charge | Rate (paise per unit) |
| Period of energy consumption | |
| • Normal peak period (06:00 AM to 5:00 PM) | Normal rate of energy charges |
| • Evening peak load period ( 5:00 PM to 10:00 PM) | 160% of Normal rate of energy charge |
| • Off-peak load period (10:00 PM to 06:00 AM next day) | 90% of Normal rate of energy charge |

As per the Tariff Order for FY 2010-11 the TOD tariff is applicable to the following consumer categories in the state:

- HV-2: Coal mines
- HV-3: Industrial, Non-industrial and Shopping Malls
- HV-4: Seasonal-includes such seasonal industries / consumers requiring energy for the production purposes for maximum continuous one hundred eighty days and for a minimum period of three months.
- HV-5: Irrigation, Public Water Works and other than agricultural- includes supply of power to lift irrigation schemes, group irrigation, Public Utility Water Supply schemes, sewage treatment plants /sewage pumping plants and for energy used in lighting pump house.
- HV-7: Bulk supply to exemptees - applies to Rural Co-operative Societies, any local authority, Panchayat Institution, users' association, Co-operatives, non-government organisations or franchisees i.e. consumers who have been granted permission under section 13 of the Electricity Act

TOD tariff is applicable for different periods of the day i.e. normal period, peak load and off-peak load period. The surcharge / rebate on energy charges according to the period of consumption are as shown in the table below:

| Peak/Off-peak Period | Surcharge / Rebate on energy charges on energy consumed during the corresponding period |
|---|---|
| Evening peak load period (6PM to 10 PM) | 15% of Normal rate of Energy Charge as Surcharge |
| Off peak load period | 7.5 % of Normal rate of Energy Charge as Rebate |

| Peak/Off-peak Period | Surcharge / Rebate on energy charges on energy consumed during the corresponding period |
|---|---|
| (10 PM to 6 AM next day) | |

*Note: Fixed charges shall always be billed at normal rates i.e. TOD Surcharge /Rebate shall not be applied on the Fixed Charges*

According to MPERC (Terms and Conditions for Determination of Tariff for Supply and Wheeling of Electricity and Methods and Principles for fixation of Charges) Regulations, 2009 (G - 35 of 2009) under Clause 40, Determination of tariffs for supply to consumers, the following has been included with respect to DSM and TOD:
*"40.1. The Commission shall determine the charges recoverable from different consumer categories based on the following principles:*

- *Incentives for energy conservation and demand side management: The Commission may prescribe incentives for energy conservation measures and demand side management.*
- *TOD incentive/ surcharge: The Commission may prescribe Time of day incentives/ surcharge for use in the specified duration of the day/ season."*

**Orissa**

The Commission has accepted the principle of Time of Day tariff since 01.04.2005. The Commission introduced TOD tariffs in the state with the following approach:
*"In accordance with Section 62 (3) of the Act and in accordance with the provision of para 7(a) (i) of OERC (Terms and Conditions for Determination of Tariff) Regulation, 2004, a differential tariff for peak and off-peak hours is essential to promote demand side management. The Commission may encourage the distribution licensee to move towards separate peak and off-peak tariffs."*

The Commission in the tariff order for FY 2005-06, decided that Off-peak hours for the purpose of tariff shall be treated from 10.00 PM to 6.00 AM. Three phase Consumers barring those mentioned below having static meters, recording hourly consumption with a memory of 30 days and having facility for downloading printout drawing power during off-peak hours were given a discount at the rate of 10 paise per unit of the energy consumed during this period. This discount, however, was not available to the following categories of consumers:

- Consumers covered under special agreement;
- Consumers who were otherwise covered under any concessional tariff like mini steel plant, new HT and EHT consumers coming into operation on or after 1st April 2005 and consumers covered under special tariff having CD of 100 MVA and above; and
- Public Lighting Consumers.

As per the Discoms Tariff Order for FY 2010-11, three phase consumers barring those mentioned below having static meters recording hourly consumption with a memory of 31 days and having facility for downloading printout drawing power during off-peak hours are given a discount at the rate of 10 paise per unit of the energy consumed during this period. The "Off-Peak Hours" for the purpose of tariff is defined as from 12.00 PM to 6.00 AM of the next day. The discount, however, is not available to the following categories of consumers:

- Public Lighting Consumers;
- Emergency supply to captive power plants.

Drawl by the industries during "off-peak" hours upto 120% of Contract Demand without levy of any penalty is also allowed.

The Commission in the Discoms Tariff Order for FY2010-11 has further stated with respect to the peak / off-peak tariff -

*"Further analysis indicates that the EHT groups of consumers generally are shifting the load from peak hours to off peak hours. That kind of trend is not visible in case of HT consumers. But, the combined load of HT consumers and area load comprising all low voltage consumers indicate*

*that more or less the peak and off peak load drawal pattern do not change. Peak load continues to remain high. This is precisely because total domestic and large part of commercial loads and other loads at low voltage generally maximize their drawal during peak hour. The total units sale at low voltage is around 40%. Licensees will have to be incentivised for installation of static meters even in case of low voltage loads. Inefficient utilisation of the existing network shall have to be addressed by having distinct peak and off peak tariff for most of the consumers. It will also help demand side management."*

**Tamil Nadu**

TOD tariff has been introduced in the state even before FY 2002-03 with incentives and disincentives for peak & off-peak hour for all HT industrial consumers.

TOD tariffs as applicable in the state based on the analysis of the Tariff Order effective from 1st August 2010 is shown as under:

Tariff category High Tension Tariff -1A: Demand charge: Rs 300/ kVA/ month; Energy charge: Rs 4 per unit. This tariff is applicable to all industrial establishments and Registered factories which includes Tea Estates, Textiles, Fertilizers, Salem Steel Plant, Heavy Water Plant, Chemical plant, common effluent treatment plant, Cold storage units, Information Technology Services Information Technology Services as defined in the Information Communication Policy (ICT Policy) 2008 of Government of Tamil Nadu.

| Particulars of TOD tariff applicable for HT Industrial consumers (HT-1A) | Period | Applicable charges |
|---|---|---|
| 0600 AM- 0900 AM<br>0600 PM- 0900 PM | Peak hours | 20% extra charge on the energy charges for the energy recorded during peak hours |
| 1000 PM- 0500 AM | Off-peak hour consumption | Reduction of 5% on the energy charges |

**Tripura**

The Commission introduced TOD tariff in the state in its Tariff Order for FY 2005-06, in consideration of the demand side management initiatives.

Details of TOD tariff as notified in the Tariff Order for FY 2005-06 are as under:

- TOD tariff is applicable to all HT consumers and 3 phase LT domestic consumers (compulsory above 3kW contracted load) subject to the availability of meter
- Applicable rate of supply is specified as under:

| Peak/Off-peak Period | Applicable Tariff |
|---|---|
| Between 5 AM to 5 PM | Normal rate |
| Between 5 AM to 11 PM | 140 % of the Normal rate |
| Between 11 PM to 5 AM | 60% of the Normal rate |

The Tariff order issued by the Commission for FY 2006-07 is still in force and as per the Tariff Order the following details have been specified with respect TOD tariffs:

- All consumers under category-Industrial, tea/Coffee/rubber Garden, Bulk Supply, Water Works & Irrigation have the option of taking TOD tariff wherein the following rates are applicable:

| Peak/Off-peak Period | Period | Applicable Energy Charge |
|---|---|---|
| Between 5 AM to 5 PM | Normal | Normal rate |

| Peak/Off-peak Period | Period | Applicable Energy Charge |
|---|---|---|
| Between 5 AM to 11 PM | Peak | 140 % of the Normal rate |
| Between 11 PM to 5 AM | Off-peak | 60% of the Normal rate |

**Uttarakhand**

The Commission introduced the concept of TOD tariff in its very first Tariff Order for the year 2003-2004 as a DSM tool. The Commission considered the following salient aspects in introducing the TOD tariff:

- Examination of the load flow curves as made available by the SLDC which indicated a predominant evening system peak throughout the year. This increase in demand from consumers had to be met by procurement from generating stations higher up in the merit order resulting in a non-linear increase in the power purchase cost
- Lowering the Diversity Factor of the system to make it equal to unity
- It is desirable from the system point of view to reduce peak demand and encourage consumption/enhance load during off peak hours
- Advantage of reducing the peak demand through TOD metering, as a tool for DSM, as it allows the utility to reduce its generation/power purchase requirement from the costlier stations, which reduces the overall cost of supply.
- Improvement in the load factor of the system due to shifting of certain peak loads to off-peak hours
- Improvement in the system load factor resulting in improvement of generation plants' PLF, thus reducing the unit generation cost.
- Reduction in the incidence of loads shedding due to reduction in peak load

The Commission has also listed certain issues in introduction of TOD metering, discussed as under:

- Meters with facility to provide time differentiated consumption data is a pre-requisite
- Mechanism by the licensee for ensuring supply to consumers who opt to shift to off-peak hours
- The time slots of hours for which differential tariff is to be given
- Tariff differential for these slots
- Intending consumers to make commitment so that load shedding is accordingly matched

A surcharge @ 25% was levied for peak hour consumption and a rebate of 5% was given for off-peak hour consumption. This arrangement continued up to Oct 2009. The Commission in its order dated Oct 2009 for FY 2009-10 modified this and tariff for peak hours consumption had been fixed at Rs 4.50/kWh instead of percentage.

Commission has analysed the impact of increasing tariff for Peak hour consumption. Commission compared consumption of 2255 consumers during Oct- Nov 2008 (old tariff) with consumption during Oct-Nov 2009 (new tariff) and found that where as overall consumption of these consumers by more than 10%, peak hour consumption has reduced by 3.34%. Out of this 3.34%, 1.73% consumption was shifted to normal hours and 1.61% to off-peak hours.

| | Oct-Nov 2008 | Oct-Nov 2009 | Increase |
|---|---|---|---|
| Normal hours | 161.48 | 188.57 | 27.09 |
| Peak hours | 135.96 | 135.15 | -0.81 |

| | Oct-Nov 2008 | Oct-Nov 2009 | Increase |
|---|---|---|---|
| Off-peak hours | 143.82 | 168.28 | 24.26 |
| Total | 441.26 | 492.00 | 50.74 |
| Ratio N/T | 36.60% | 38.33% | 1.73% |
| Ratio P/T | 30.81% | 27.27% | -3.34% |
| Ratio O/T | 32.59% | 34.20% | 1.61% |

*Source: UERC*

Details of TOD tariffs currently applicable in the state as per Tariff Order for FY2010-11 are as under:

- TOD tariff is applicable for RTS-7: LT Industry above 25kW and HT Industry- includes all consumers of electrical energy for industrial and /or processing or agro- industrial purposes, power loom as well as to Arc/Induction Furnaces, Rolling/Re-rolling Mills, Mini Steel Plants and to other power consumers not covered under any other Rate Schedule. It also includes Vegetable, Fruits, Floriculture & Mushroom integrated units farming, Processing, storing and Packaging units.
- The rates of energy charge specified for LT industry with load more than 25 kW and HT industry are subject to TOD rebate/surcharge.
- TOD meters have to be read by Meter Reading Instrument (MRI) only with complete dump with phasor diagram, Tamper Reports, full load survey reports etc. shall be downloaded for the purpose of complete analysis and bills shall be raised as per TOD rate of charge.
- No meter is to be read at zero load or very low load. Licensee has to carry appropriate external load and apply the same wherever necessary to take MRI at load.
- Copy of MRI Summary Report has to be provided along with the Bill. Full MRI Report including load survey report have to be provided on demand and on payment of Rs 15/ Bill.
- TOD load is specified as under:

| Season/ Time of day | Morning Peak hours | Normal Hours | Evening peak hours | Off-peak hours |
|---|---|---|---|---|
| Winters<br>01.10 to 31.03 | 0600-0930 hrs | 0930-1730 hrs | 1730-2200 hrs | 2200-0600 hrs |
| Summers<br>01.04 to 30.09 | | 0700-1800 hrs | 1800-2300 hrs | 2300-0700 hrs |
| (Rebate)/Surcharge | 25% | 0% | 25% | -5% |

- TOD rate of energy charge for LT Industry is specified as:

| Particulars | Rate of Charge (Rs./kVAh) |
|---|---|
| Normal hours | 2.95 |
| Peak hours | 4.42 |
| Off-peak hours | 2.65 |

- TOD rate of energy charge for HT Industry is specified as:

| | Rate charge during (Rs./ kVAh) | | |
|---|---|---|---|
| Load Factor | Normal hours | Peak Hours | Off-peak Hours |

| | Rate charge during (Rs./ kVAh) | | |
|---|---|---|---|
| Load Factor | Normal hours | Peak Hours | Off-peak Hours |
| Less than 33% | 2.60 | 4.65 | 2.34 |
| Above 33% and up to 50% | 2.85 | 4.65 | 2.57 |
| Above 50% | 3.10 | 4.65 | 2.79 |

Where,

Load factor = (Consumption during the billing period) x 100
(Maximum Demand or Contracted Demand whichever is less) x (No. of hours in the billing period)

The Commission in the Tariff Order for FY 2010-11 has specified for the RTS-2 Non-Domestic consumer category that:

- All consumers above 25 kW shall necessarily have TOD meters.
- TOD meters installed for consumers having sanctioned load of 25 kW and above shall be read by Meter Reading Instrument (MRI) only and complete dump with Phasor Diagram, Tamper Reports, full load survey reports etc. shall be downloaded for the purpose of complete analysis.
- No meter shall be read at zero load or very low load. Licensee shall carry appropriate external load and shall apply the same wherever necessary to take MRI at load

**Uttar Pradesh**

TOD tariffs have been introduced in the state since FY 2003-04. To start with TOD tariff was applicable to the HV-2 (Large and Heavy Power) consumer category which included all consumers who had a contracted load of more than 75 kW (100 BHP) for industrial and/or processing purposes as well as to Arc / Induction Furnaces, Rolling / Re-rolling mills, Mini steel plants and Floriculture & Mushroom farming units and to any other HT consumer not covered under any other Rate Schedule. The tariffs were also applicable for the consumers of commercial light, fan & power consumers (LMV-2 category) and small & medium power consumers (of Rate Schedule LMV-6), subject to the condition that the contracted load of such consumer was above 50kW and such consumer opted to be billed under this category.

Prior to the introduction of TOD tariffs for HV-2 consumer category in FY 2003-04, Commission had continued with the practice of charging the consumers opting for supply during restricted hours at a higher rate.

Rationale for introduction of TOD tariffs in the state

The Commission had underlined the following approach for introduction of TOD tariffs in the state (tariff order for FY 2002-03):

*"The licensee has to contract for the power accordingly; during peak hours when demand is the highest, the licensee has to buy power from peak run plants such as the gas based ones which have higher variable cost when compared to the base load thermal and hydro (run off the river) plants. The licensee has to also develop its Transmission capability commensurate to the peak load it is required to serve. According to the marginal cost principle, the consumer that causes this incremental cost for providing additional unit of energy and power during peak hours should be billed for it. Also the principle of fairness requires that the consumers responsible for imposing the peak hours cost burden must pay for it. This will in turn also help the licensee in flattening the curve thus reducing peak shortages and the overall cost of energy. However, the beginning can be made with industrial consumers due to the restricted availability of TOD meters".*

TOD tariffs set by the Commission in the year FY2003-04 have been shown in the table below:

| HV-2 Tariff Urban Schedule | For supply at 11kV | For supply above 11kV & up to 66kV | For supply above 66kV & up to 132kV | For supply above 132kV |
|---|---|---|---|---|
| BASE RATE (URBAN SCHEDULE) | | | | |
| Demand Charges (Rs./kVA) | 180 | 170 | 165 | 160 |
| Energy Charges (Rs./kVAh) | 3.50 | 3.35 | 3.25 | 3.15 |
| Minimum Charges (Rs) | 5100/year (425/month) | 5100/year (425/month) | 5100/year (425/month) | 5100/year (425/month) |
| BASE RATE (RURAL SCHEDULE) | | | | |
| Demand Charges (Rs./kVA) | 155 | 145 | 140 | 135 |
| Energy Charges (Rs./kVAh) | 3.00 | 2.85 | 2.75 | 2.65 |
| Minimum Charges (Rs./kVA/Year) | 4020/year (335/month) | 4020/year (335/month) | 4020/year (335/month) | 4020/year (335/month) |
| TOD rebate(-) / premium(+) on energy charges during daily time-slots | | | | |
| 2200 hrs – 0600 hrs | (-) 5% | (-) 5% | (-) 5% | (-) 5% |
| 0600 hrs - 1700 hrs | 0 | 0 | 0 | 0 |
| 1700 hrs - 2200 hrs | (+) 25% | (+) 25% | (+) 25% | (+) 25% |

**Minimum Charge amount indicated above is Rs. per kVA or part thereof per year of the contracted load payable monthly at the rate mentioned against each, subject to final adjustment in the last bill of the year of accounting.*

As per the tariff order for FY 2009-10, TOD tariff is applicable to the following consumer categories:

- HV–2 (Large and Heavy Power) which includes all consumers having contracted load above 75 kW (100 BHP) for industrial and / or processing purposes as well as to Arc/induction furnaces, rolling/re-rolling mills, mini-steel plants and floriculture & farming units and any other HT consumer not covered under any other rate schedule.

The existing base tariff rates and TOD rates as approved by the Commission are given in the table below:

| Urban Schedule | For supply at 11kV | For supply at 33kV & 66 kV | For supply at 132kV | For supply above 132kV |
|---|---|---|---|---|
| BASE RATE | | | | |
| Demand Charges (Rs./kVA/ month) | 230 | 220 | 200 | 200 |
| Energy Charges (Rs./kVAh) | 4.60 | 3.85 | 3.75 | 3.75 |
| TOD rebate(-) / premium(+) on energy charges | | | | |

| Urban Schedule | For supply at 11kV | For supply at 33kV & 66 kV | For supply at 132kV | For supply above 132kV |
|---|---|---|---|---|
| during daily time-slots | | | | |
| 2200 hrs – 0600 hrs | (-) 7.5% | (-) 7.5% | (-) 7.5% | (-) 7.5% |
| 0600 hrs - 1700 hrs | 0 | 0 | 0 | 0 |
| 1700 hrs - 2200 hrs | (+) 15% | (+) 15% | (+) 15% | (+) 15% |

*Source: Tariff Order FY 2009-10*

The above rate schedule is applicable also to consumers getting supply up to 11 kV as per 'Rural Schedule'. The consumer under this category is entitled to a rebate of 15% on 'Rate of Charge' as given for 11 kV consumers under urban schedule without TOD rates.
As per the Tariff Order for FY 2009-10 it is stated with respect to new connections that:
*"New connection of 25 kW & above loads for Light, Fan & Power and 25 BHP & above for Motive Power Loads shall be given with installation of demand recording Static Tri-vector Meter (TVM) or TOD meters as may be appropriate. Licensee shall ensure installation of Tri-vector Meter (TVM) or TOD meters (Demand Recording Meters), (as may be appropriate) on all existing consumers with load of 25 kW/ 25 BHP and above as the case may be."*

**West Bengal**

TOD tariff has been mentioned right from the first tariff order in the state FY 2001-02. Based on the analysis of the tariff orders, it was observed that TOD tariff is applicable to both LT as well as HT consumers in the state and it is optional for some consumer categories whereas for others it has been made compulsory.

Salient aspects with respect TOD tariff which the Commission has specified under Chapter 3 (Relevant Factors to be considered for Determination of Tariff) of the WBERC Tariff Regulations, 2007 are:

*"3.1.1 To promote demand side management, tariff for consumer may be differentiated by the Commission on the basis of time at which supply is required.*

*3.1.2 To enhance optimum utilization of transmission and distribution network, the Commission may differentiate the transmission tariff / charges or wheeling tariff / charges or both of any licensee on the basis of the time at which supply is required."*

With regard to incentivisation of supply of power on the basis of time of day the WBERC Tariff Regulations state as under:

*"3.2.1 To incentivise the peaking supply capability of thermal generating stations of a generating company to a licensee, the Commission may introduce separate tariff for peak, off-peak and normal period by differentiating on the basis of average tariff subject to the condition that none of the differentiated tariffs will be less than the cost of generation (average tariff minus the sum of the components of reasonable return) which is allowed by the Commission. However, none of such differential tariff shall be higher than 15% of the average tariff…*

*3.2.2 To incentivise the peaking supply capability by a licensee to another licensee and the reduction of peak and off-peak drawl ratio by the electricity drawing licensee from the supplying licensee, the Commission may introduce separate tariff for peak, off-peak and normal period by differentiating on the basis of average tariff….."*

With respect to the TOD metering the Tariff Regulations clearly state that:

*"3.12.1 The Commission may make TOD or pre-paid metering mandatory within certain time frame for any class of consumers as may be specified by the Commission in due course besides those already covered in Annexure – C2.*

*3.12.3 The Commission may differentiate tariff or rebate or discount or surcharge or penalty for use of TOD and / or pre-paid meter to provide incentive for efficient use of electricity, ensuring better demand side management and for increased operational efficiency of licensee."*

For the consumers under TOD Tariff the segregation of time period as per the Tariff Regulations and as per latest Tariff Order is as under:

- TOD Scheme A:
  - Normal Period: 6.00 AM – 5.00 PM
  - Peak Period: 5.00 PM- 11.00 PM
  - Off-peak Period: 11.00 PM – 6.00 AM
- TOD Scheme B:
  - Normal Period: 6.00 AM – 5.00 PM and 8.00 PM – 11.00 PM
  - Peak Period: 5.00 PM- 8.00 PM
  - Off-peak Period: 11.00 PM – 6.00 AM

TOD Scheme A is applicable to the following categories of consumers:

- **LV & MV consumers:** Commercial (rural, urban),Irrigation, Commercial plantation , short term irrigation supply, short term supply for commercial plantation, short term supply, Cottage Industry / Artisan / Weavers / Small production oriented establishment not run by electricity as motive power, Poultry, Duckery, Horticulture, Tissue culture, Floriculture, Herbal – Medicinal – Bio-diesel Plant Farming, Food Processing Unit, Industries (Rural, Urban), Emergency supply, Bulk Supply at single point to Cooperative Group Housing Society
- **HV & EHV consumers:** Industries, Community irrigation, Commercial plantation , short term irrigation supply, short term supply for commercial plantation, Commercial, Domestic, Cold Storage for perishable items, Cold Storage for non- perishable items, Emergency supply, Bulk Supply at single point to Cooperative Group Housing Society, Traction load for transport system, Short term supply.

TOD Scheme B is applicable to the following categories of consumers:

- **LV & MV consumers:** Public Utility / Specified Institutions / Public Bodies, as applicable (Municipal area , Non- Municipal area), Public Water Works & Sewerage System, Private Educational Institutions & Hospitals, Construction Power Supply, Common Services of Industrial Estate
- **HV & EHV consumers:** Public Utility, Public Water Works & Sewerage System, Construction Power Supply, Common Services of Industrial Estate.

For all class of consumers the applicable tariff scheme and optional tariff scheme includes the following combinations allowed with TOD as per the Tariff regulations:

- 'Normal – TOD' tariff means the tariff which is to be paid on the basis of the bill raised, after consumption of electricity in a billing cycle, as per regulations framed under section 50 of the Act and such tariff will be differentiated on the basis of time of the day;
- 'Prepaid – TOD' tariff scheme means the scheme under which advance payment is to be made for use of certain quantity of electricity and such tariff will be differentiated on the basis of time of the day.

The TOD tariff applicable for various consumer categories as per the tariff order of WBSEDCL for FY2010-11 is shown in **Annexure – V** to this report.

As per Tariff Regulations, TOD Tariff scheme in a consumer mode is not applicable to any consumer, whose partial demand is met by supply through open access as open access customer and balance demand in consumer mode. Further for such a consumer where normal tariff scheme is not available then for such case the tariff for normal period under available TOD scheme for such class of consumer shall be applicable for 24 hours of a day inclusive of peak and off-peak hours.

Any consumer who has captive generating set shall also not have any TOD scheme of tariff in consumer mode. The Commission has also provided voltage-wise graded load factor rebate to the EHV and HV industrial consumers as a measure to reduce T&D losses and flatten the system load curve by improving the existing system load factor of WBSEDCL.

### Andhra Pradesh

TOD tariff has been introduced in the state for the consumers of HT-1 category, from 1st August 2010 onwards. TOD tariff has been introduced in the evening time slot of 6pm to 10 pm. The applicable tariff is tabulated as under:

| Consumer Category | Fixed Charge (Rs/HP/ month) | Demand Charge (Rs/ kVA/ month) | Energy charge (Rs/ unit) |
|---|---|---|---|
| **HT-1A Industry General** | | | |
| 132 kV | 0.00 | 250 | 2.97 |
| 33 kV | 0.00 | 250 | 3.25 |
| 11 kV | 0.00 | 250 | 3.52 |
| Lights & Fans | | | |
| 132 kV and above | 0.00 | 0.00 | 4.67 |
| 33 kV | 0.00 | 0.00 | 4.70 |
| 11 kV | 0.00 | 0.00 | 4.72 |
| Colony | | | |
| 132 kV and above | 0.00 | 0.00 | 4.0 |
| 33 kV | 0.00 | 0.00 | 4.0 |
| 11 kV | 0.00 | 0.00 | 4.0 |
| Seasonal Industries | | | |
| 132 kV and above | 0.00 | 250 | 4.10 |
| 33 kV | 0.00 | 250 | 4.30 |
| 11 kV | 0.00 | 250 | 4.80 |
| Time of day tariff (6pm to 10 pm ) in addition to the above charges | - | - | 1.0 |

*Source: Retail Tariff Schedule for FY2010-11*

### Delhi

TOD tariff has not yet been introduced in the state. The Commission had introduced seasonal TOD tariff for the industrial category in the Tariff Order for FY2009-10.

**Haryana**

The Commission has specified the PLEC (Peak Load Exemption Charges) but the same have not been implemented by the Distribution licensees in the state till date.

Peak Load Exemption Charges on HT industrial consumers were allowed to be levied by HERC on consumers who were given special dispensation during peak load hours. Accordingly, instructions were issued vide S.C. No.4/2001 dated 11.1.2001 against sub-head (ix) of item-4 i.e. HT industrial and Steel Furnace Power Supply as below:

*"Item: 4. (ix) Peak Load Exemption Charge (PLEC)*
*The H.T. industrial consumers where metering is through Electronic Tri-vector Meters, using electricity by availing permitted special dispensation or exemption during peak load hours notified by the Licensee from time to time shall be billed at extra charge of Re. 2/- per kWh over and above the normal tariff on the consumption recorded by the Electronic Tri-vector Meter during this period. If the consumption of a consumer during peak load hours in a month exceeds the prescribed limit, the consumption during peak load hours shall be charged @ Rs.4/- per kWh extra over and above the normal tariff. The permissible load equivalent to percentage of contract demand during peak load hours shall be converted into units by the following formula.*

| Permissible consumption | Contract Demand Allowed |
|---|---|
| Contract demand allowed during the month | In KVA x Average standard power factor x No. of peak load hours x 30 |

*Note: Average standard power factor shall be taken as 0.90.*

*All HT industrial consumers with Electronic Tri-vector Meters who have not sought/ granted special dispensation, can avail 10% of Contract Demand during peak load hours and the consumption recorded during such peak load hours shall be subject to additional charge and regulated as mentioned above."*

The salient features of PLEC in the state are outlined as under:

- The peak timing is considered as 05:00 to 07:00 and 19:00 to 23:00; peak load hours shall be notified by the Licensee from time to time.
- The consumption during peak hours shall be billed at extra charge of Re. 2/- per kWh over and above the normal tariff on the consumption recorded by the Electronic Tri-vector Meter during this period.
- If the consumption of a consumer during peak load hours in a month exceeds the prescribed limit, the consumption during peak load hours shall be charged @ Rs.4/- per kWh extra over and above the normal tariff.

**Rajasthan**

TOD tariff has not yet been introduced in the state. Commission has asked the distribution licensees to present their proposal in the tariff petitions. As per the order dated 31.08.2007, the distribution licensees have been directed to include the concept of TOD tariff mechanism at least for those category of consumers having higher contract demand, say 1500 kVA to begin with.

**Punjab**

TOD tariff has not been implemented in the state. From the analysis of the Tariff Orders it is observed that Peak Load Exemption Charges (PLEC) have been in force in the state since 1998.

With respect to implementation of TOD, it is observed from the Tariff Order for FY 2009-10, that the Commission is awaiting a comprehensive proposal from the Board:
*"The Tariff Policy provides for implementation of Two Part Tariff featuring separate fixed and variable charges and for fixing TOD tariff on priority for large consumers (say consumers with demand exceeding 1 MW).The Commission is awaiting a comprehensive proposal from the Board."*

### Commission's approach

The Commission in the Tariff Order for FY 2004-05 has stated regarding continuance of Peak Load Exemption Charges (PLEC) as under:

*"A number of Industrial Consumers and Industrial Consumers Associations have objected to the continuation of levy of Peak Load Exemption Charges for using electricity during evening peak hours and have requested for withdrawal of the same…*

*The Board in its reply has stated that the power supply system in Punjab is a constrained one and there is an acute shortage during peak hours and an excessive drawl results in lowering system frequency and may result in grid failure. The excess power supply during evening peak is arranged from most expensive sources. As such, a fixed commitment by the consumer is essential…*

*The Commission has considered the matter and notes that there is no denying the fact that there is acute shortage of power in the State especially during peak load hours. Overdrawing under ABT during this period costs much higher than the average power purchase cost and goes up to even Rs.6/- per unit. The Commission also notes that recoveries made through PLEC are duly accounted for in the tariff income of the Board. As such, both the additional cost of power purchase during peak hours and the recoveries through PLEC are duly taken care of in the Board's expenditure and receipts. The system therefore, does not require any change in this regard. The existing rate of PLEC is also not considered unreasonably high especially in view of the exorbitant extra costs of power purchase involved. The Commission further notes that in acute shortage situation of power in peak hours, the PLEC has to be based on the extra load reserved by the consumer and not as per actual use. This is because if the Board reserves the load for the consumer, it is committed to supply that power and has to make arrangement accordingly to fulfill this commitment. In view of the commitment of the Board which in any case stands, it is not so material whether the extra power is actually drawn by the consumer or not.*

### Peak Load Exemption Charges (PLEC)

All Large Supply (LS) Consumers except essential services such as Hospitals, Railway Stations, Railway installations, Defence & Military installations, AIR/TV, Water Supply & Sewerage installations, P&T installations & News Services installations are required to observe peak load hour restrictions. These restrictions are for 3 hours continuously with the time of imposing the restrictions varying according to the season. During these restrictions, consumers are allowed to run a part of their load and may seek permission of the Board for using higher loads on payment of PLEC.

As per the Tariff Order for FY 2008-09 , PLEC charges are calculated @ Rs.120/- per KW of permitted load beyond reduced load per month if the permitted load during peak hours is up to 100 KW. When the permitted load exceeds 100 KW PLEC charges are calculated on the load permitted for peak hours @ Rs.1.80 per KW per hour up to 65 % of Contract Demand and Rs.2.70 per KW per hour for exemption allowed beyond 65% of Contract Demand. The PLEC charges are calculated for a minimum of 3 hours per day and these charges are recoverable over and above the normal energy bill.

## Conclusion

Based on the analysis of the TOD implementation as carried out in detail for the states where TOD tariff is applicable the following conclusions can be drawn:

- In states such as MP, Chhattisgarh, Gujarat, West Bengal, Assam, Tamil Nadu, TOD tariff has been mentioned right from the first Tariff Order, which implies that TOD tariff have been applicable in these states from an earlier period.
- Although most of the states have specified the TOD tariffs, to begin with HT Industrial and commercial consumers, but there is the issue of lack of data being submitted by the utilities on load profiling after the introduction of TOD tariff. This has had an impact on the proper

implementation of TOD tariffs in the form of rationalizing TOD tariff, providing rebates during off-peak hours, rolling out TOD tariffs for other consumer categories.

- The approach of SERCs in introducing TOD tariffs has been principally guided by the following:
  - As per sub-section (3) Section 62 of the Act
  - As a Demand Side Management measure
  - FOR recommendations
  - Provisions of the NTP and NEP
- The time period specified as Peak hour, Off-peak hour and Normal period for TOD tariff varies from state to state. In states such as Uttarakhand, HP, SERCs have specified different time period for summers and winters. In states such as West Bengal, Commission has specified different time period to be applicable for different consumer categories.
- The TOD tariffs specified by the Commissions varies from state to state and the salient approaches adopted are :
  - Symmetric peak hour energy charges and off peak hour energy charges/rebates – Karnataka
  - Asymmetric peak hour energy charges and off peak hour energy charges/rebates- specified in most of the states
  - Flat concession to the consumers opting for TOD metering & billing- Orissa
  - Only Peak hour charges are applicable- Gujarat (HTP consumers)
  - TOD tariff specified for a consumer category varies according to season-summer, monsoon and winters-West Bengal (WBSEDCL)
  - there is a provision of only reduced tariff in the off peak hour (Orissa)
- The TOD tariffs as applicable in most of the states (Maharashtra, West Bengal, HP, MP, Gujarat, Uttarakhand, UP, Kerala, Tamil Nadu, Tripura) are compulsory for HT and EHT consumers, whereas is in rest of the states it is optional.
- The TOD tariffs have been made compulsory in some of the states (Uttarakhand, Maharashtra, West Bengal) for LT (non-residential/ commercial, industry) and MV (commercial, industry) consumers above a certain threshold load. In Tripura TOD tariff is compulsorily applicable for a LT consumer having a 3-phase connection with a connected load of 3kW and above, subject to the availability of TOD meters.
- In States like West Bengal clauses pertaining to the implementation of Time of Day Tariff have been detailed in the Tariff Regulations. The tariff regulations in West Bengal have also provided provisions for time based tariff for the supply of power from generation plants, which is definitely a progressive step.
- Some of the states like Punjab, Haryana have specified PLEC and this is being used as a tool for controlling demand during peak hours. Whereas in HP, PLEC in addition to PLVC charges are also applicable.

# 3. Analysis of TOD in selected states

## Background

Economic theory suggests that price of a good which maximizes social surplus is equal to its marginal cost of production. In case of electricity, this would be the cost of producing the last unit (kWh) of electricity. Since the price is the amount paid for increments of consumption, it should be reflective of the incremental cost of supply of electricity. In this regard, the marginal cost of a unit of energy could be used to determine the price of energy, thereby representing incremental resource cost of supply.

The cost of supply will increase if the existing consumers raise their consumption or new consumers are added to the system. Therefore, prices should be related to the economic value of future resources that will be utilized to meet such demand increases. A tariff based on Long Run Marginal Cost (LRMC) appears consistent with the objective of efficient resource allocation.

Though there may be an economic sense to price electricity at strict LRMC, the practical scenario would have to factor in the socio economic status of the customers, objectives of the government and the drive of the utilities to keep investments low, thereby creating a situation of cross-subsidies in the tariff rates.

## TOD Tariff & load factor improvement

The system load factor of distribution utility gives an important indication as to how efficiently it caters to the demand of its consumers. The load factor is defined as the ratio between the average demand and the peak demand for a given period of time. A higher load factor is desirable as this implies that the average power generation is closer to the maximum demand of consumers, denoting a higher operational efficiency of power plants. This also means that plant fixed costs may be spread over larger number of generated units, thereby giving a lower cost per unit.

Another incentive to reduce the gap between the peak and average demand is the increasing marginal costs of generation with increase in demand. Since as per Merit Order dispatch, plants with higher costs are dispatched to meet the demand over the average, the higher the peak-load of the system, the higher is the cost of electricity.

Further, by reducing the peak load, the fixed cost of meeting a given demand can be lowered, as any increase in demand can be accommodated without additional investments in new generation capacities. Also, security of supply can be increased without additional cost.

Thus the relationship between TOD tariff and improving the load factor is quite apparent. By charging different tariff at peak and off-peak periods according to marginal cost, customers are incentivized to shift their loads to off-peak hours, thereby reducing the overall system peak demand and improving the system load factor.

## Framework for analysis

In most of the states TOD tariff has been introduced as a means of DSM measures and load factor improvement. The SERCs have followed diverse mechanisms in designing the TOD tariff, with different tiers, different number of periods within a day, and different rates applicable to these periods. Hence it is pertinent to analyze the relationship between the TOD tariff and the load factor as a measure of the impact analysis for TOD as a DSM measure.

The focus of the analysis has been to analyse the relationship between the ratio of average peak to off-peak tariff levels and the load factor over a time period for which the data is available with the utility.

The interpretation of the data for analysis has been done as under in order to have a comparison across the states and consumer categories with respect to the analysis of the impact of TOD:

- Since within a state different customer categories are imposed with varying TOD tariffs, the peak or off peak tariff for the analysis, has been considered as the average of peak or off-peak rate for respective categories;
- In states with more than 2 time bands within a day, the rates have been time weighted across the number of hours it is applicable; and
- For the calculation of the system load factor, the average consumption and peak demand has been taken.

Consumer category wise impact of introduction of TOD tariff can be done by analysing the hourly load curve for a particular consumer category before and after the imposition of TOD tariff. By analyzing the hourly load curve the relation between ratio of peak and off-peak tariffs and impact of the same on shifting load to off peak hours i.e. improving system load factor can be established.

The rational deduction of the framework as discussed above has been that higher the difference between the peak and off-peak tariffs over a period of time, higher should be the incentive for consumers to shift their electricity consumption pattern. In this regard, it has been further assumed that, the load factor may continue to increase with the increase in the ratio of peak to off-peak rates, and taper off at the maximum achievable load factor for a particular consumer category.

**Study in selected states**

The following process was adopted for undertaking detailed analysis of the impact of TOD tariff in selected states:

(a) Selection of states in consultation with the FOR Secretariat : Following states were selected for detailed analysis:
   i. Maharashtra
   ii. West Bengal
   iii. Assam
   iv. Karnataka
   v. Uttar Pradesh

(b) Preparation of information format (Refer Annexure-I) for seeking information from the utilities in the selected states for analysis of the –
   i. System peak and energy shortages after introduction of TOD tariff;
   ii. Impact of load shifting and demand-side management at consumer category level after introduction of TOD tariff;
   iii. Cost of TOD metering.

(c) Analysis of the information furnished by the utilities

(d) Analysis of the secondary information

**Impact analysis of TOD Tariffs in selected states**

The analysis carried out in this section is based on the data submitted by the utilities in response to the information format prepared by the Consultants for the study attached as Annexure-I to this report.

**Response of the utilities**

The utilities in the selected states have not been able to provide consumer category wise data based on which the TOD impact analysis could have been possible at the consumer end. The utilities have provided their system level data, based on which the analysis has been carried out in this report.

Although the data submitted by the utilities in various states is limited/ partially complete, but an attempt to analyse the impact of TOD tariff with the available information has been done in this section in accordance to the framework for analysis of the impact of TOD tariff.

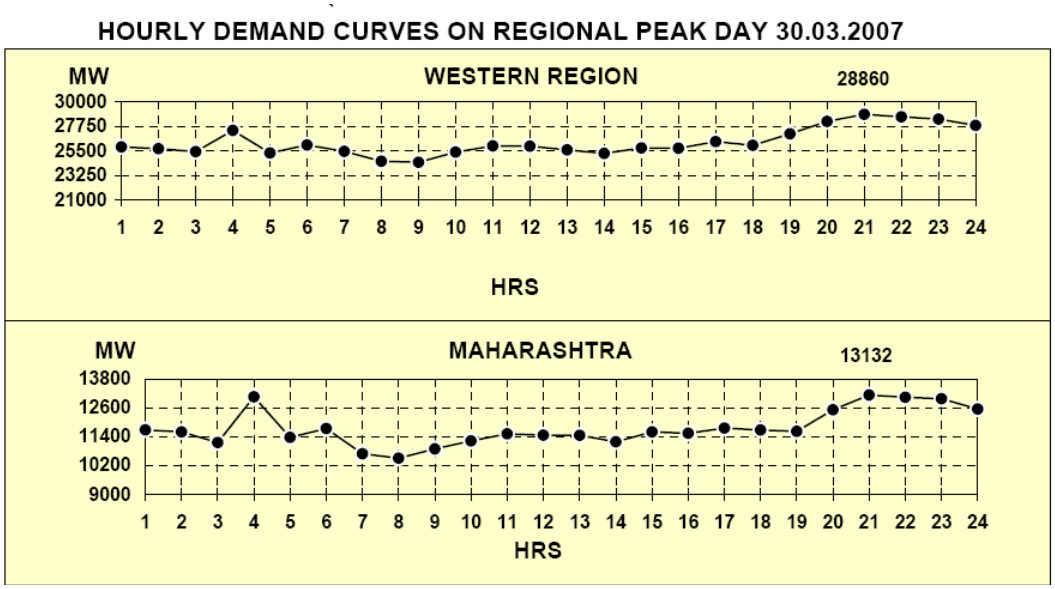
The secondary analysis carried out in this section has been based on the information available from respective regional load dispatch centres, respective SLDCs and respective regional power committee reports. The granularity of the information collected on a secondary basis varies from state to state.

**Maharashtra**

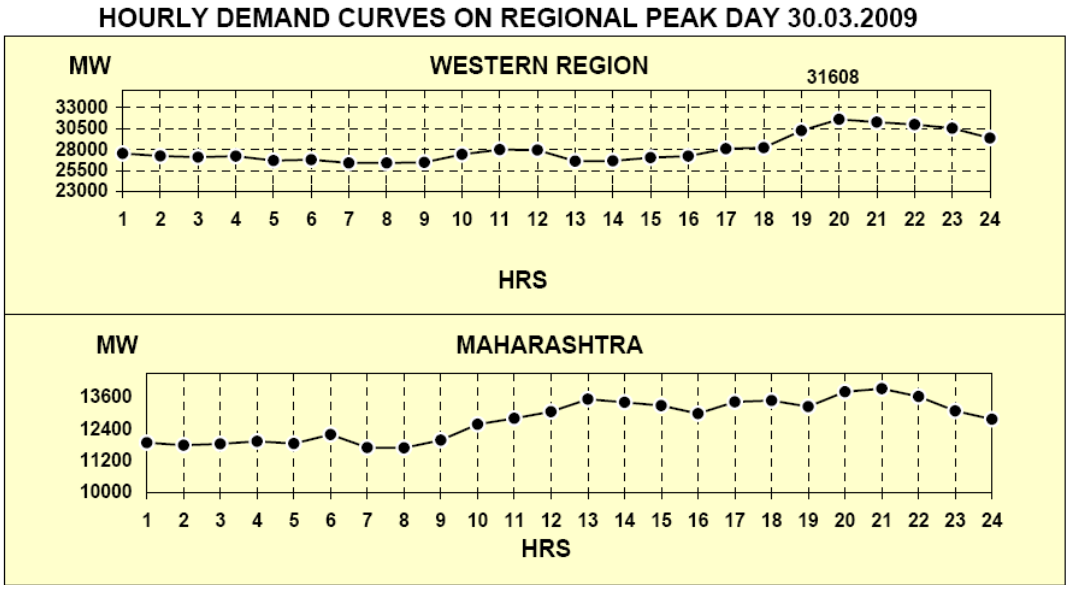
Load profile of western region & state

The analysis of the regional grid load profile is important to ascertain the time of occurrences of peak in the grid and to analyse the shift of state's demand vis-à-vis the regional load profile.

The Western region load profile for FY 2006-07 and the load profile for the state of Maharashtra as shown below clearly depicts that the state had similar load profile to that of the regional grid.

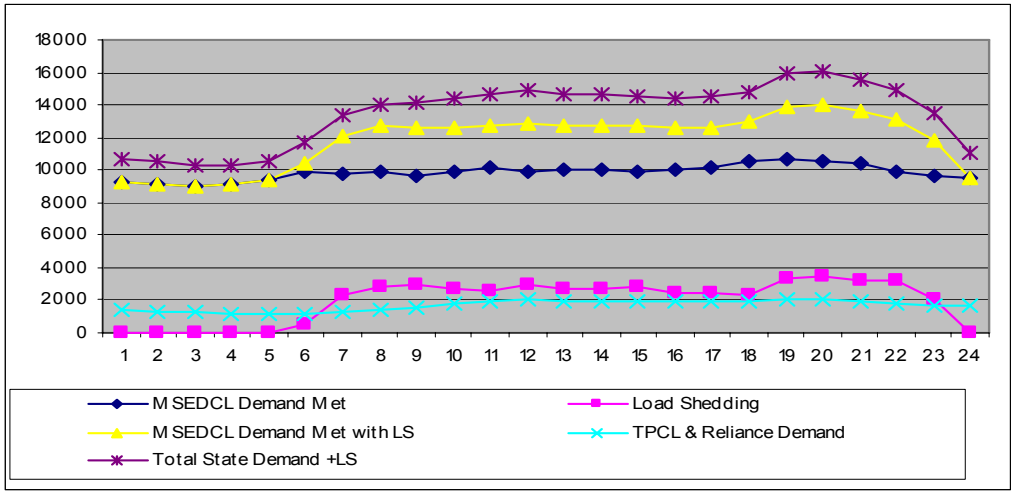



The change in the load profile of the system in the state vis-à-vis the regional grid profile is clearly depicted in the load profile of the state for FY 2008-09, wherein it is apparent that there has been a shift in the demand profile especially in the time slot 1000-1800 hrs as compared to that of the regional grid, where the demand during these time periods is low.

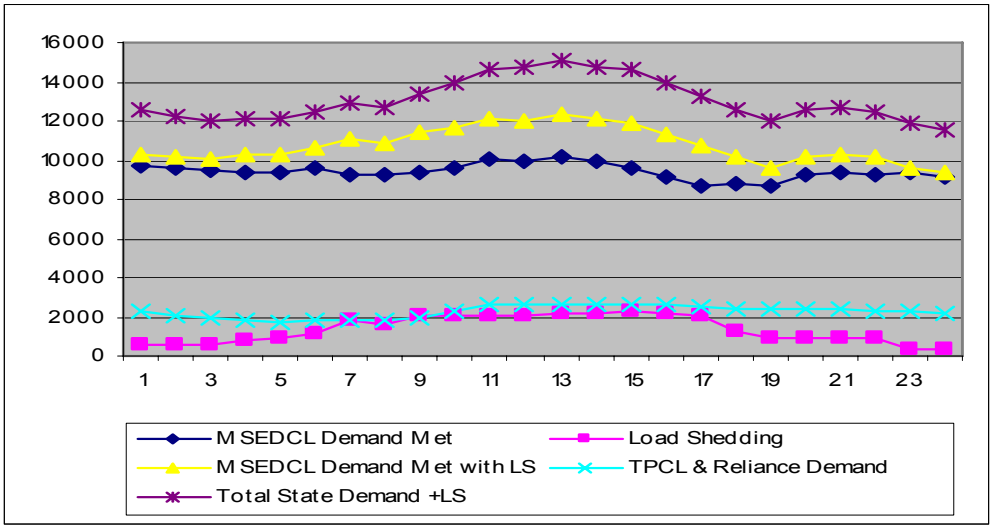



*Source: WRPC Annual Report*

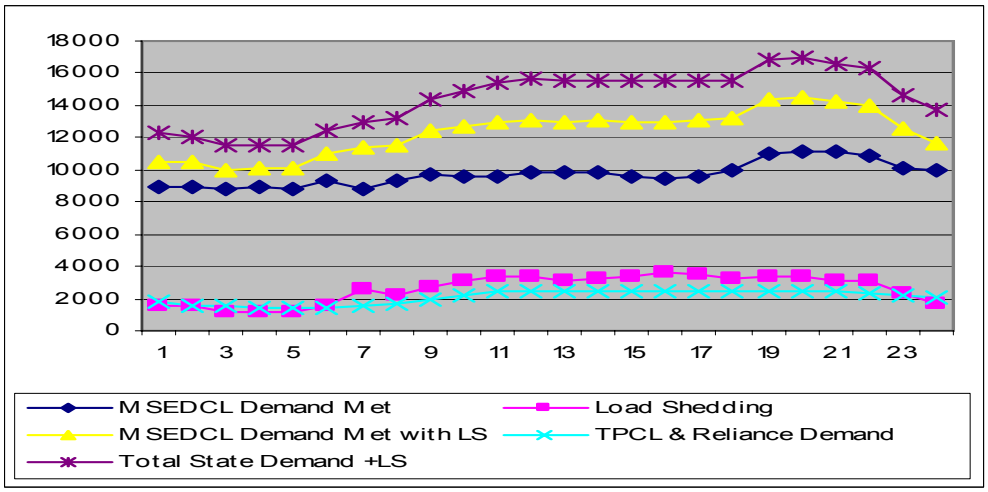
Based on the analyses of the hourly data obtained from WRLDC, SLDC the load curve profile for the state has been plotted as under. It is quite apparent from the graphs shown below pertaining to different time of the year FY 2009-10 that load shedding is being used to maintain the load profile for the state.




*Load profile as on 01.01.2010*




*Load profile as on 20.06.2009*




*Load profile as on 20.10.09*

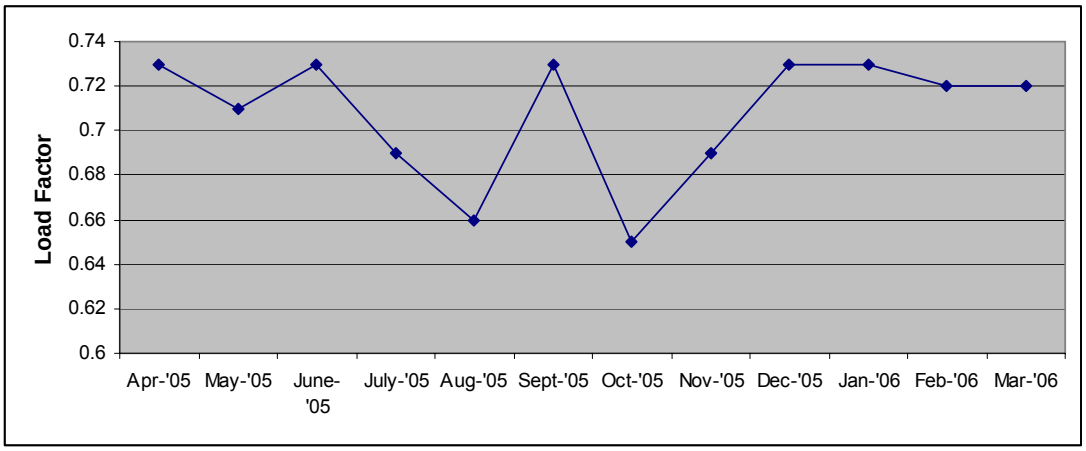
### Data from Distribution Licensees

TPC-D and MSEDCL have submitted the data with respect TOD in the state. There has been no response from other utilities in the state on the data submission.

### Analysis of data submitted by TPC-D

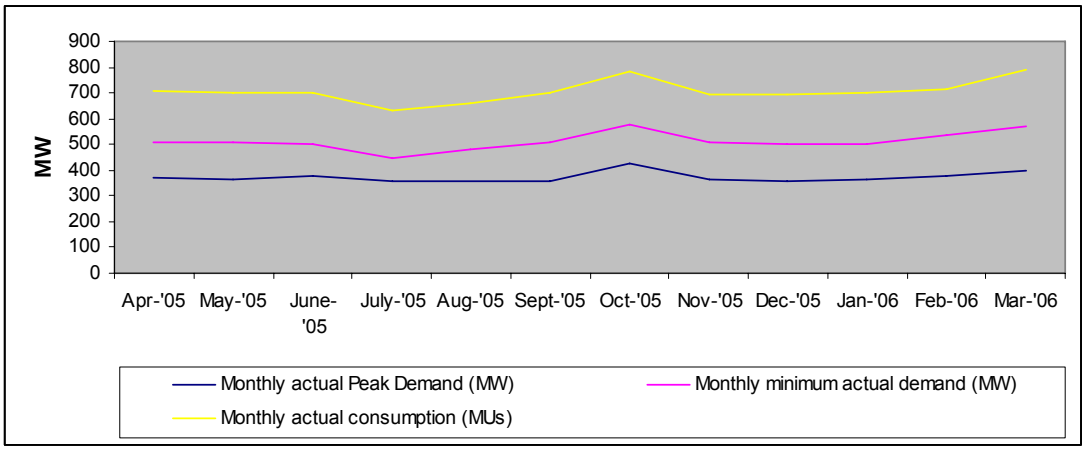
TPC-D has submitted the TOD data for the period FY2005-06 to FY2008-09. The data submitted for FY2005-06 corresponds to the year prior to the introduction of TOD tariff.

The monthly load factor profile of the system under TPC-D shows that the load factor for the utility varies in the range of 0.65-0.73 for FY 2005-06.




The utility has not been able to furnish the consumer category wise hourly load data since the same has not been recorded by the utility.

The monthly load profile for the system prior to the introduction of the TOD tariff optional for LT–II & HT consumer categories applicable from October 2006 is depicted in the chart below:

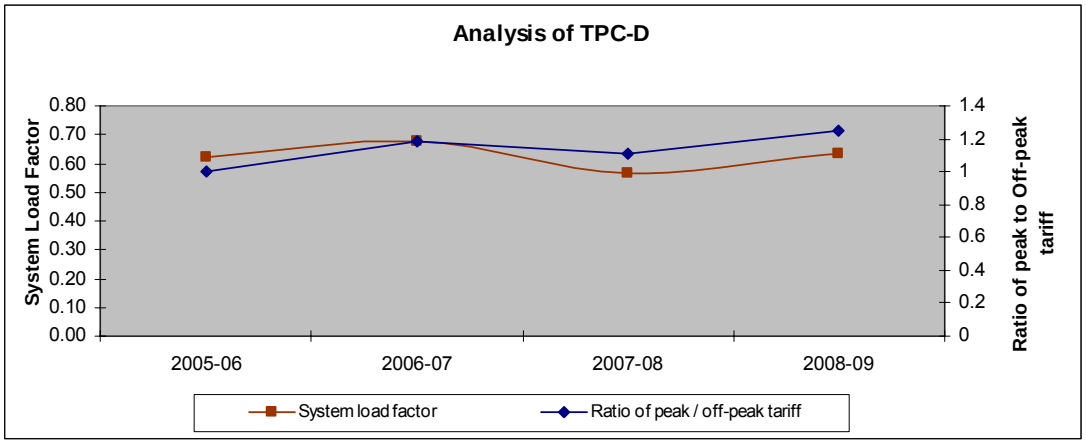



The monthly load profile of the utility post introduction of TOD tariff in Oct 2006 has not seen much change as compared to the previous year. The differential tariff introduced in the Tariff order for FY 2005-06 and 2006-07 was 60 paise above the respective base tariff for LT-2 (LT Industrial & Commercial above 15 HP load) HT consumer categories, applicable from 1800-2200 hrs.

The analysis of the yearly information about TPC–D peak demand and average demand reveals the following facts:

- The optional TOD tariff was introduced in Oct, 2006.The system load factor in 2006-07 showed an improvement over the system load factor in FY 2005-06. The ratio of peak to off–peak tariff for HT industrial consumer category stood at 1.18 in FY 2006-07.
- There was no change in the optional TOD tariff for FY 2007-08 for the LT industrial and HT industrial & commercial consumer categories, where as although the base energy tariff was revised downwards for industrial consumers but there was introduction of “Reliability Charge” comprising of standby charges and expensive power charges. There was a drop in the ratio of peak to off-peak charges for HT industrial consumer category, which coincided with the drop in the overall system load factor.

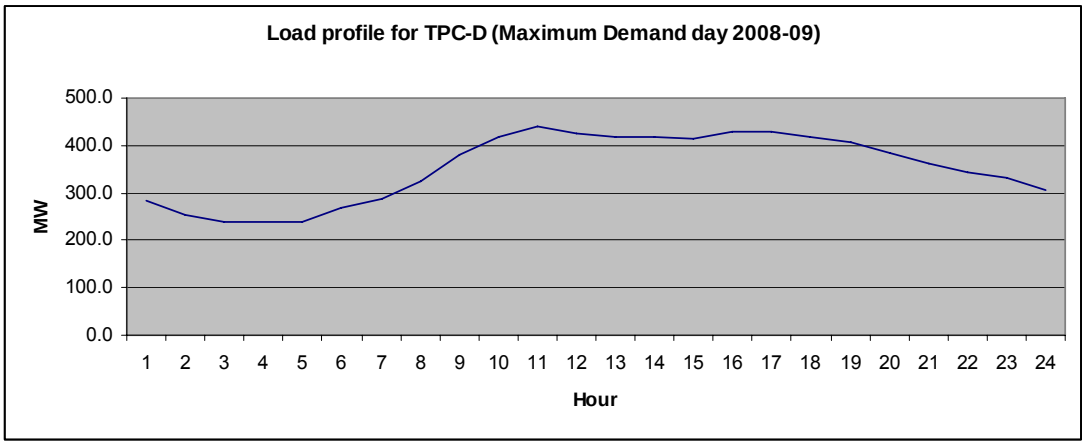
- In the year 2008-09 TOD was made compulsory for LT commercial & industrial consumers above 20 kW load and optional for LT commercial & industrial less than 20kW. TOD was also made compulsory for HT Commercial and industrial consumer categories. TOD tariff structure in 2008-09 was spread over 5 time bands and in the off-peak period a reduction in base energy charges were also given. The system load factor in 2008-09 has shown an improvement over the previous year, which coincided with the improvement in the system load factor.

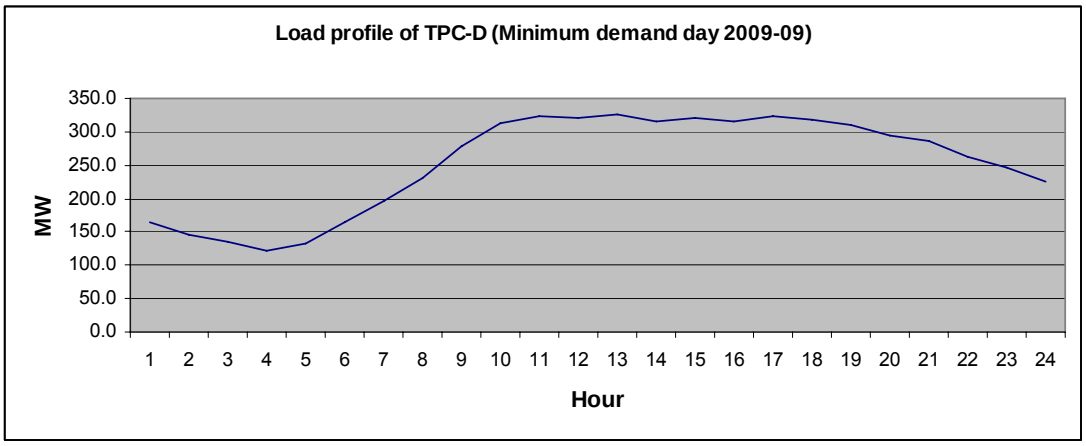



- Thus it is quite apparent based on the analyses of the available data that, introduction of compulsory TOD since 2008-09 in the state has also had a positive impact on the load shifting, apart from other DSM factors/ incentives.

The analysis of the load profile of TPC-D for Maximum demand day (29th May 2008) and on Minimum demand day (11th January 2009) reveals that the load profile of the TPC-D system is fairly flat from 1000 hrs to 2000 hrs, however there is further scope for shifting of load in the off peak hours (2400 hrs to 0900 hrs).

The off–peak hours for TPC-D system is similar to that of the entire state , however the peak hours of TPC-D system vary with respect to that of entire state, which could be a result of the difference in the consumer mix connected to the TPC-D system as compared to that of the other Licensees in the state.



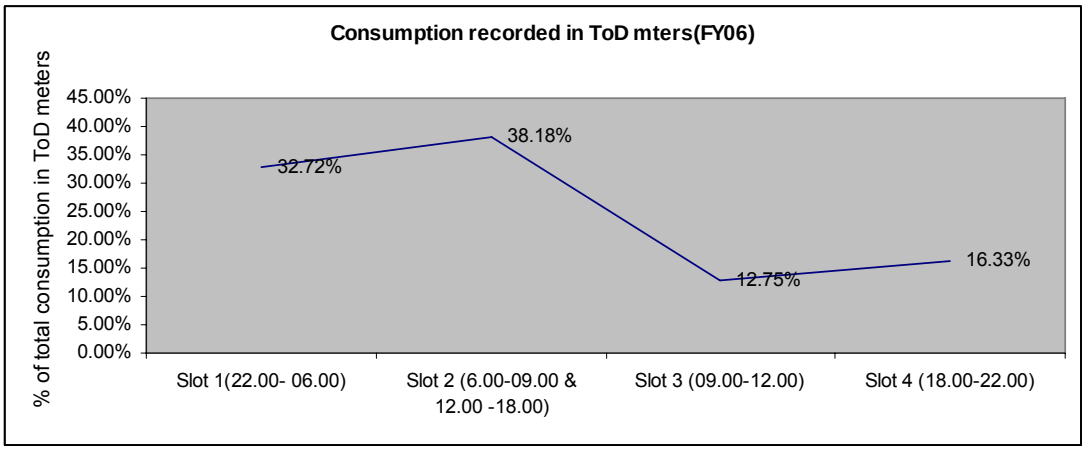



### Analysis of data submitted by MSEDCL

MSEDCL has submitted the TOD meters information in the state which depicts the monthly consumption recorded by TOD meters installed for each category of consumers in each time slot and the coverage in % terms of TOD meters installed against the total number of consumers under respective categories.

The above data has been submitted for the period FY 2005-06 to FY 2009-10.The section below depicts the analyses of the information submitted by MSEDCL:

- The consumption profile as recorded in the TOD meters under different time slots in the year 2005-06 are as under:



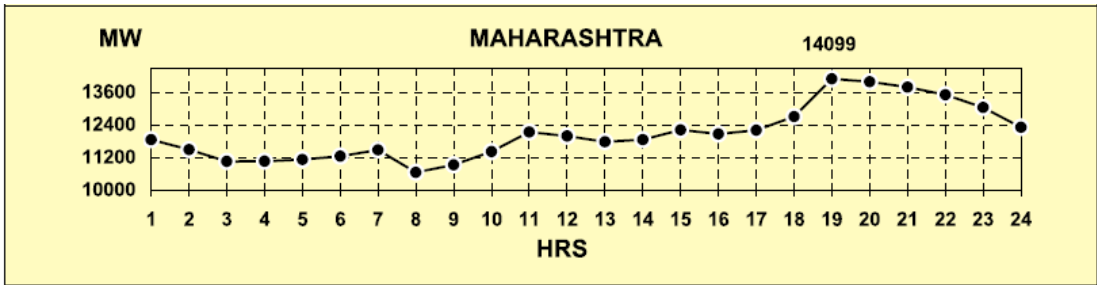

- Comparing the TOD consumption with the load profile for the state on the maximum demand day in FY 2006-07 reveals that TOD consumption per slot over the various time slots is nearly identical across various time slots, which can arise only due to implementation of forced load shedding.
- Based on the analysis of the TOD consumption data for all categories for which TOD is applicable in FY 2006-07 it is observed that the consumption pattern in the time slots in FY 2006-07 is similar to the consumption pattern observed in FY 2005-06.
- It is observed in general that although the peak tariff period is 1800-2200 hrs but the consumption is more than the 0900-1200 hrs tariff period in which period, the applicable energy charges are marginally lesser than that in 1800-2200 hrs.

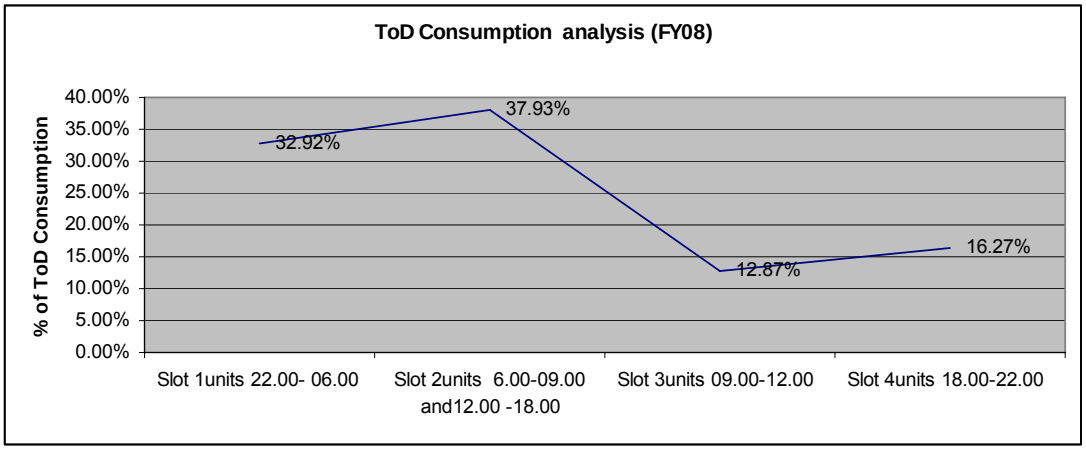
- The TOD tariffs applicable to consumer categories in FY 2005-06, FY 2006-07 are outlined as under. The TOD tariffs in FY 2006-07 were applicable to HT I–Industries, HT III–Waterworks, HT VI–Seasonal Industry and LT V–General Motive Power.

| Time Slot | TOD tariff in paise/unit (FY 2005-06) (w. r. t base tariff) | TOD tariff in paise/unit (FY 2006-07) (w. r. t base tariff) |
|---|---|---|
| 2200 hrs-0600 hrs | -85 | -85 |
| 0600 hrs-0900 hrs & 1200 hrs- 1800 hrs | 0 | 0 |
| 0900 hrs-1200 hrs | 60 | 80 |
| 1800 hrs -2200 hrs | 100 | 110 |

- The analysis of the TOD consumption profile for FY 2007-08 is shown as under:

**HOURLY DEMAND CURVES ON REGIONAL PEAK DAY[1] 08.11.2007**

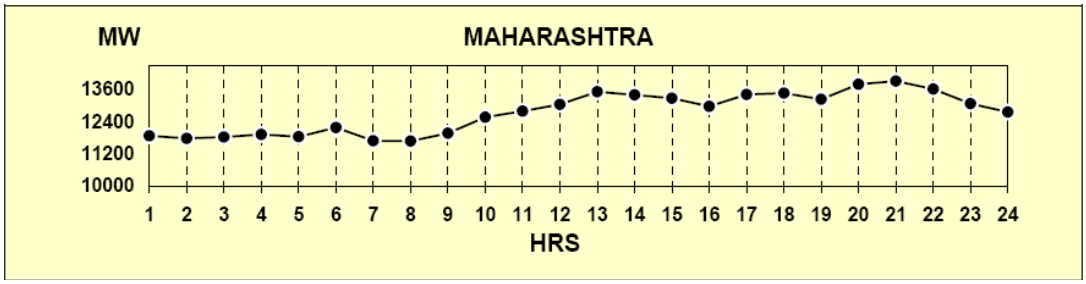


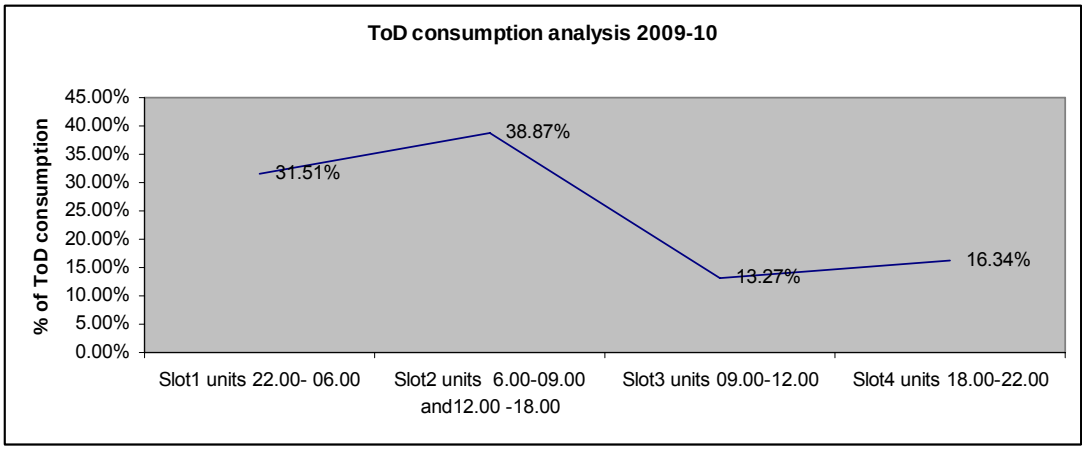




It is apparent from the analysis of the TOD consumption in FY 2007-08 & FY 2009-10 that even as there has been increase in the overall consumption by the consumers covered under TOD meters but the pattern of consumption within the TOD time slot has changed little since FY 2005-06. Further there is still ample scope for increasing the TOD consumption in the 0600-0900 hrs time slot whereas there can be case for still increasing the tariff differential in case of peak tariff to be applicable for the time slot 1800-2200 hrs.

**HOURLY DEMAND CURVES ON REGIONAL PEAK DAY[2] 30.03.2009**

[1] Source: WRPC Annual report




### Conclusion

It is apparent from the analysis of the load curve of the system that the introduction of TOD tariff besides other measures has had an impact in the state's load profile, however due to huge supply-demand gap in the system the load curve profile of the state is being maintained through load shedding.

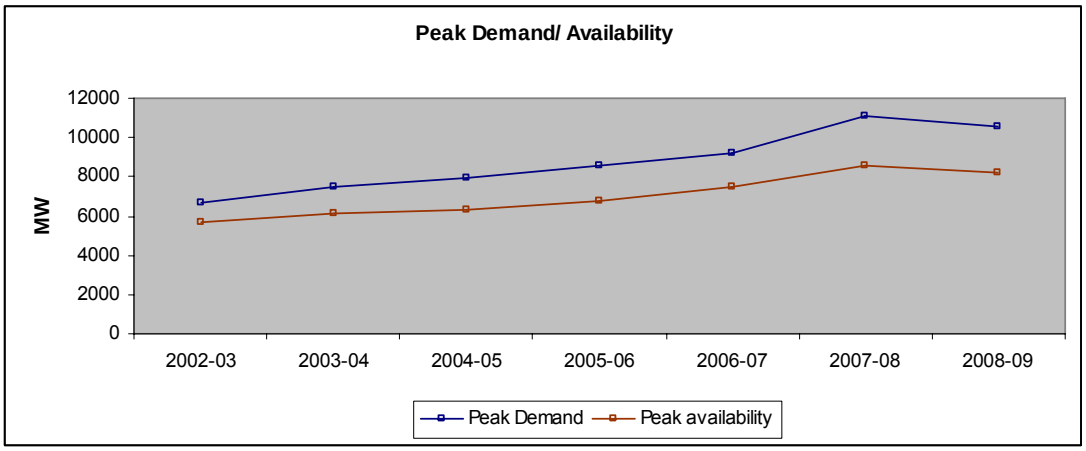
## Uttar Pradesh

### Load profile of northern region

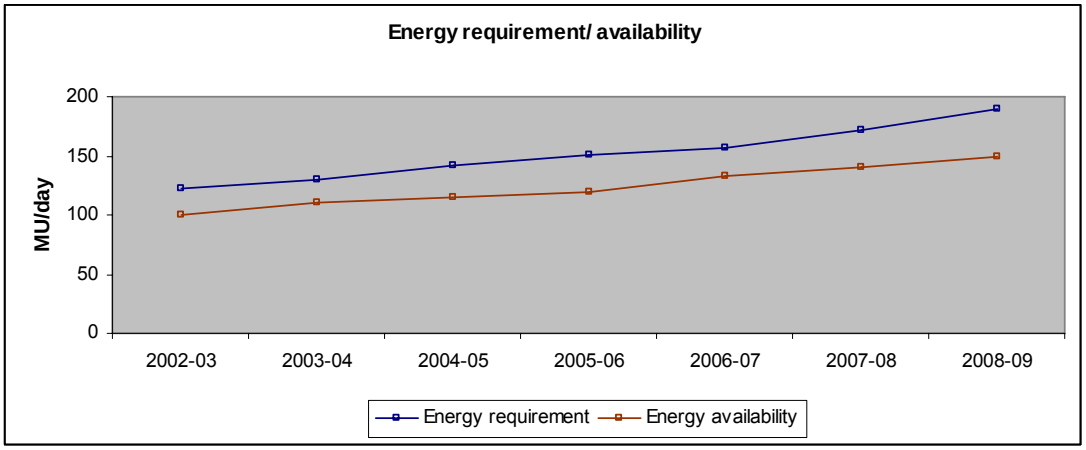
The analysis of the load curves for the Northern grid depicts that the state has its peak and off peak period coinciding with the regional grid peak & off-peak period.

Based on the analyses of the data obtained from NRPC, it is seen that over the years there has been increase in the energy requirement and peak demand of the state.

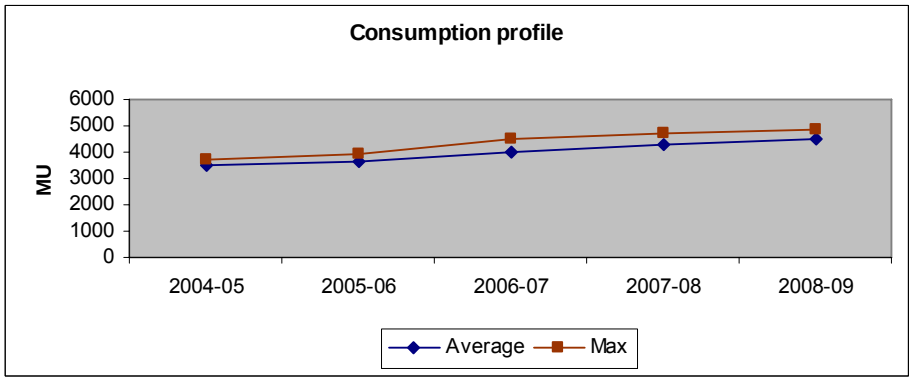
[2] Source: WRPC Annual report




The average gap between the peak demand and availability in the period between FY03-FY 2008-09 has been 24.66%, whereas the average energy deficit during the same period has been 22.69%.

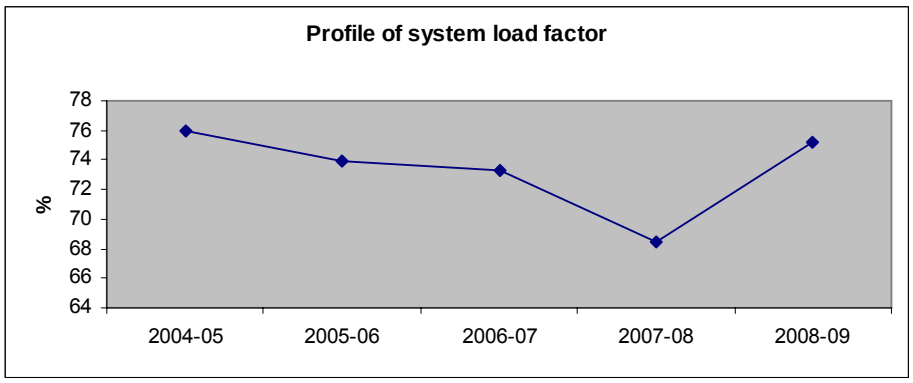



The average monthly energy consumption in the state has shown an increasing trend over FY 2004-05 to FY 2008-09 and the maximum monthly energy consumption has also shown an increasing trend over the period as shown in figure below.




*Profile of average consumption and maximum consumption (MU)*

The system load factor for the state has remained in the range of 76%-68% during FY 2004-05 to FY 2008-09 as shown in figure below.




*Profile of system load factor*

### Data from Distribution Licensees

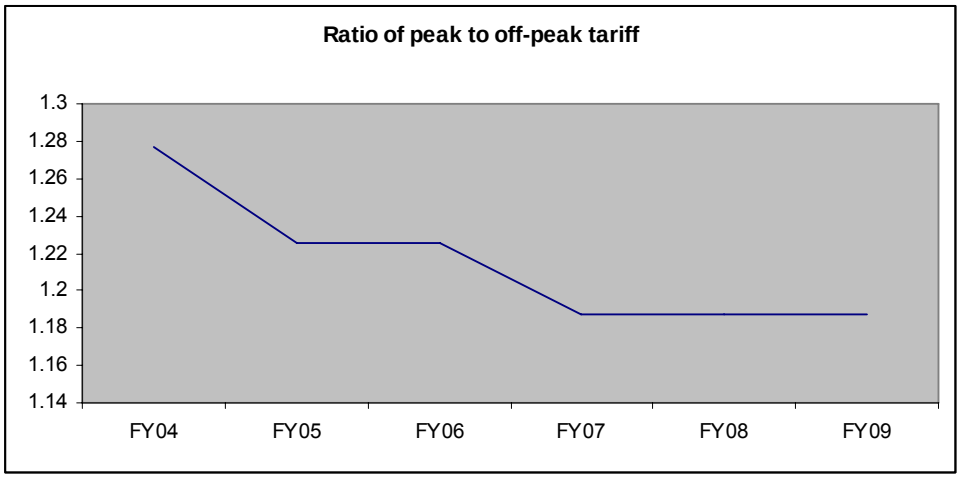
Noida Power Corporation Ltd. and UPPCL have submitted the partial data. Based on the analysis of the partial data submitted by the Licensees very little information of significance on TOD impact could be drawn. However analysis of the impact of TOD tariff has been attempted in this section based on the additional data sourced from SLDC.

*UPPCL*

The data submitted by UPPCL does not reveal any significant impact of TOD tariff in light of the fact that the state has a significant deficit in average demand and peak demand and it is difficult to deduce from the data submitted by the utility any impact of TOD tariff.

UPERC has also stated in the Tariff Order for FY 2007-08 and FY 2008-09 with respect toD tariff: *"The Commission does not have any consumption history of the consumers in the category in desired detail to assess the revenue impact of the application of TOD rates on the consumers of the category."*

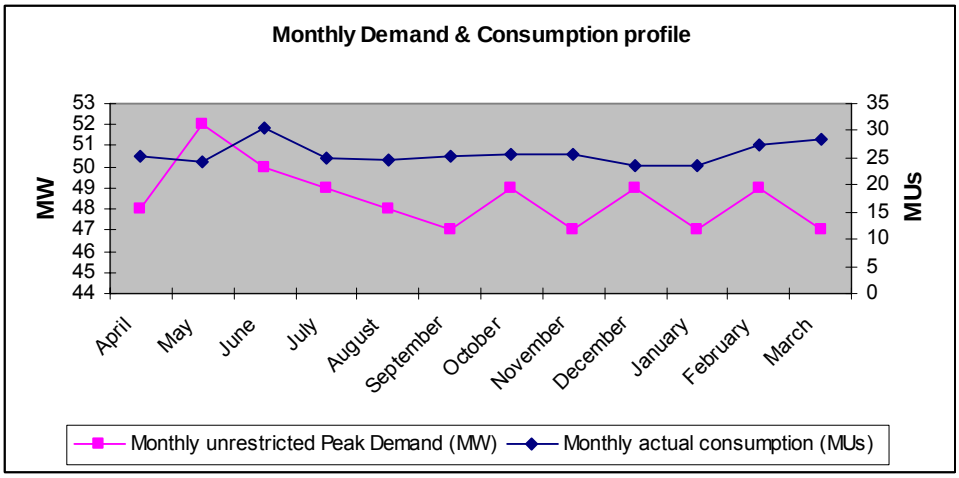
The analysis of the TOD tariff approved by the Commission over the years for the HV-2 consumer category reveals that the tariff differential between and off peak tariff (time weighted) has decreased over the years although there has been increase in the consumer categories covered under HV-2 category.




*NPCL*

The analysis of the NPCL system load profile reveals that the system load factor is in the 80% range.

NPCL has provided TOD data on Large & Heavy industries for which the TOD is compulsory. The analysis of the monthly data for HV-2 consumer categories reveals that the load factor for this consumer category is low in the range of 33%-38% whereas the ratio of peak to off-peak tariff is 1.24, which means that there is further scope of improvement in the load factor of the utility's system with appropriate tariff differential between peak and off-peak tariff.




### Conclusion

Due to the incomplete data submitted by the utility in the state no conclusion can be drawn on the impact of TOD tariff in the state.

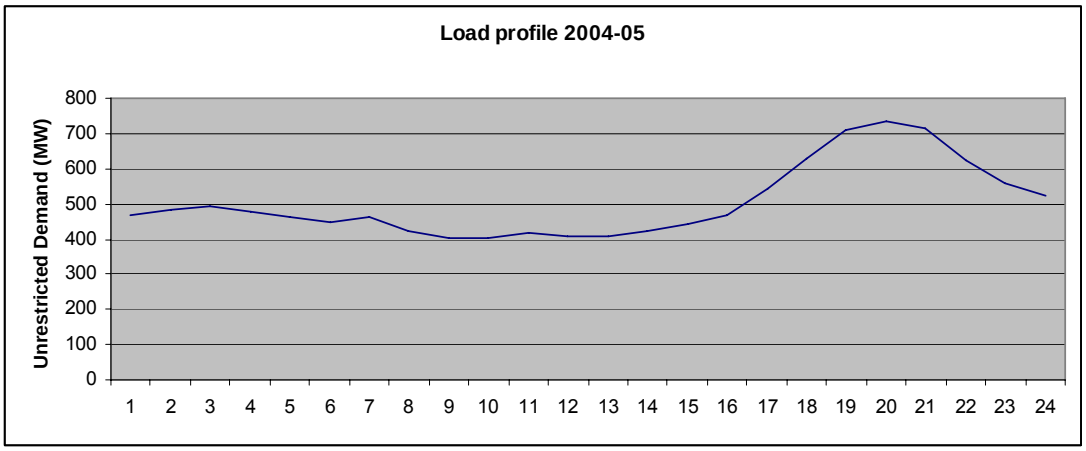
## Assam

### Load profile of northern east region

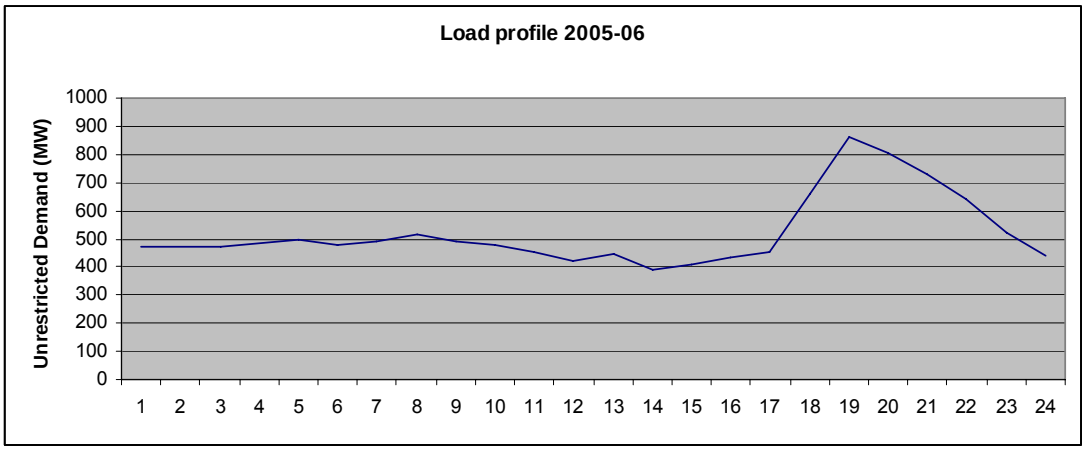
The analysis of load profile of the regional grid and the state reveals that the state has high peak demand and due to limited own generation as well as the nature of generation, the state is dependent on the grid for meeting its peak requirement.

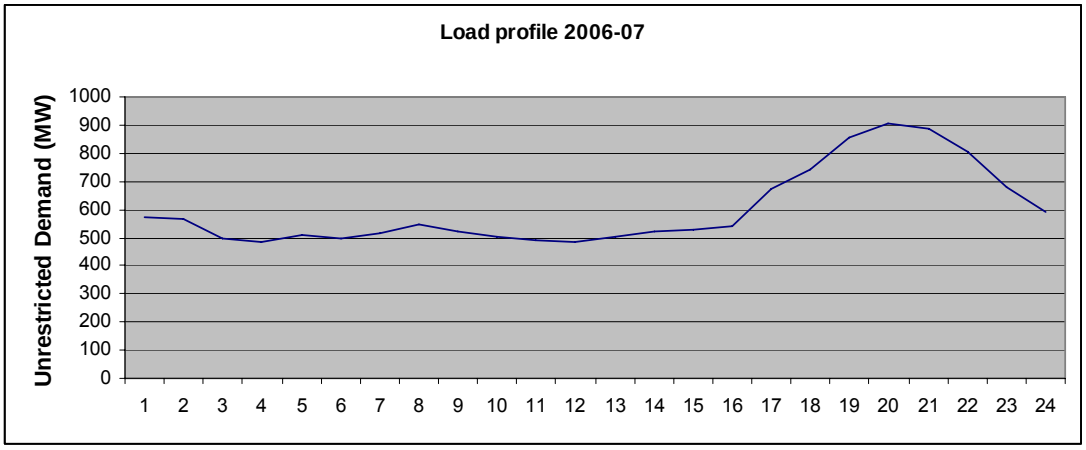
### Data from Distribution Licensees

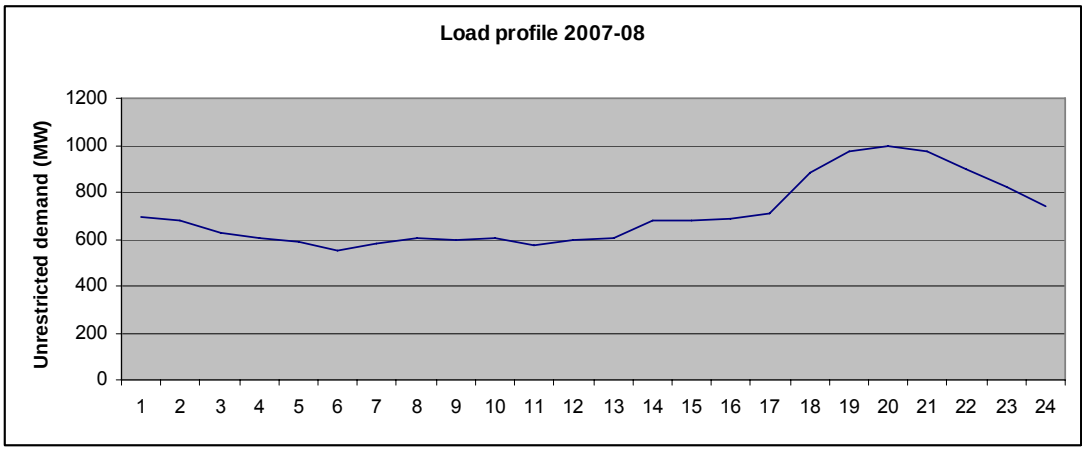
Based on the analysis of the data provided by the utilities in the state it is observed that higher demand during evening hours is a characteristic of state's load curve. The load curves plotted for unrestricted demand on maximum demand day for the state over a period depicted as under, reveals flattening of load curve to a certain extent.

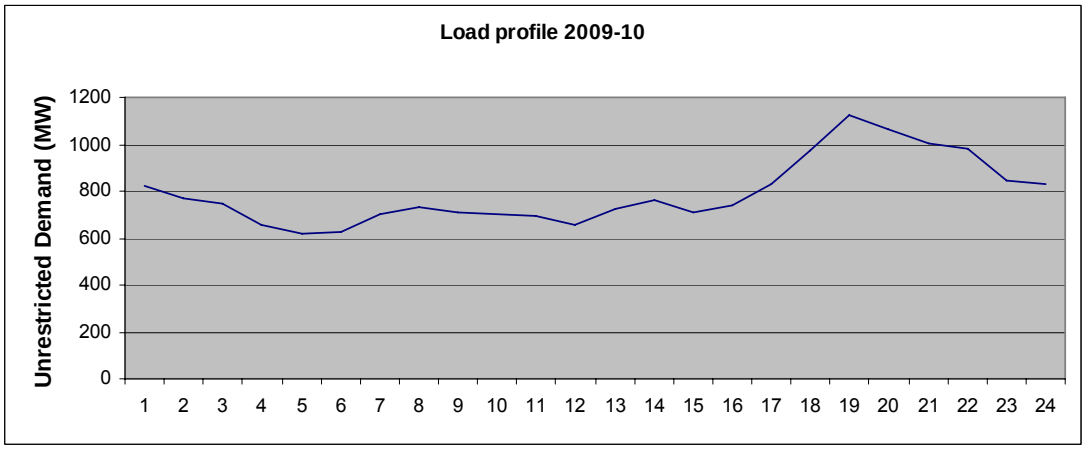



The state had two-tier TOD tariff structure in FY05. The three-tier TOD tariff introduced in the Tariff Order for FY 2005-06 for some categories has achieved the purpose to some extent of shifting the load from peak to non-peak hours. The categories of consumers where this tariff is applicable often adjusts its power consumption timing from evening peak hours to day or night hours when the tariff is relatively low. The load profile of the state over various years has been plotted as shown in the figures below:



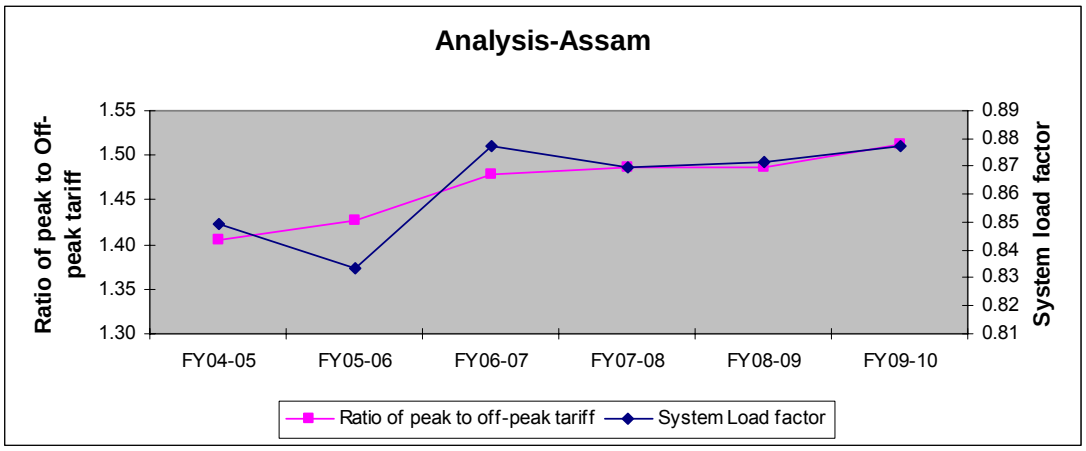



TOD tariffs have been applicable in the state since FY 2004-05 as per tariff order and these were introduced by the Commission for the categories of HT industries, Tea, coffee & rubber, and oil & coal.

In the Tariff Order for FY 2007-08, the Commission has stated that there was intention to extend the benefit of TOD tariff to other HT category of consumers (domestic, commercial, public water works, HT Small industries and HT Irrigation). However, further extension of TOD tariff to other main HT group like commercial & domestic categories has not been considered on account of lack of proper data.

The analysis of the load factor of the system in the state and the ratio of peak to off-peak tariff reveals that with the increase in the ratio of peak to off-peak tariff, the system load factor has also improved barring FY 2005-06, however any further improvement in the load factor of the system shall depend upon extending the TOD tariff to other consumer categories.



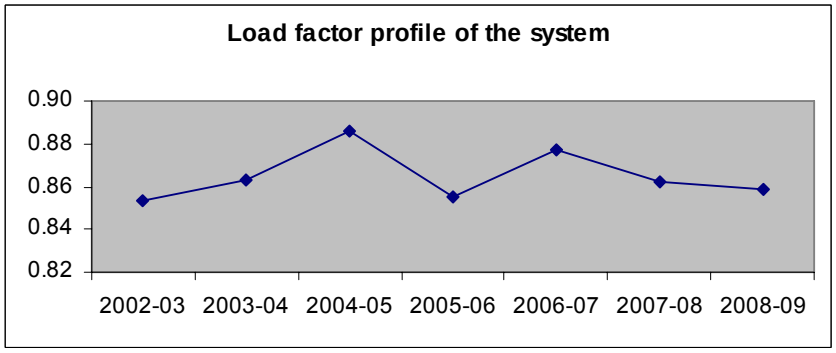

### Conclusion

Any further improvement in the system load factor would require extension of TOD tariff to other consumer categories also remaining HT consumers (domestic, commercial, public water works, HT Small industries and HT Irrigation) and the residential consumers above threshold connected load.

## West Bengal

### Load profile of eastern region

Based on the analyses of the secondary data obtained from ERLDC, it is seen that the load factor for the state[3] has initially improved till FY 2004-05 and then from FY 2006-07 onwards there has been a decline.



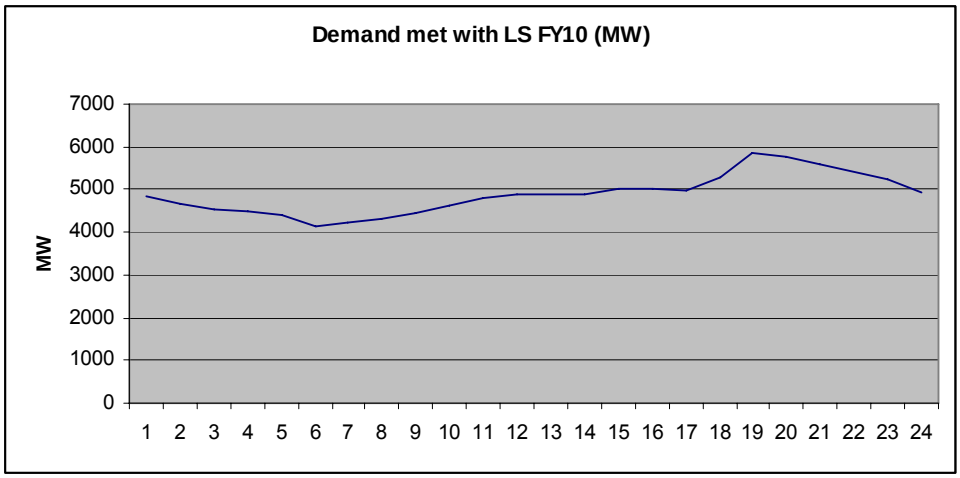

*Profile of load factor for the state*

Based on the analysis of the load profile of the eastern region it is observed that the in FY 2009-10 the state met the shortfall in the peak demand through the load shedding whereas in FY 2008-09 the peak demand in the state was met without resorting to any load shedding. The analysis of the average monthly energy consumption for WBSEB shows a steady increase over the period FY 2002-03 to FY 2008-09.

### Data from utilities

[3] Also includes Sikkim and Durgapur Projects Limited

Based on the data submitted by WBSETCL, the load profile of the state on maximum demand day(with Load Shedding) depicts that the state has a fairly flat load profile except in the evening peak hours and morning off peak hours (0400 hrs – 0900 hrs).

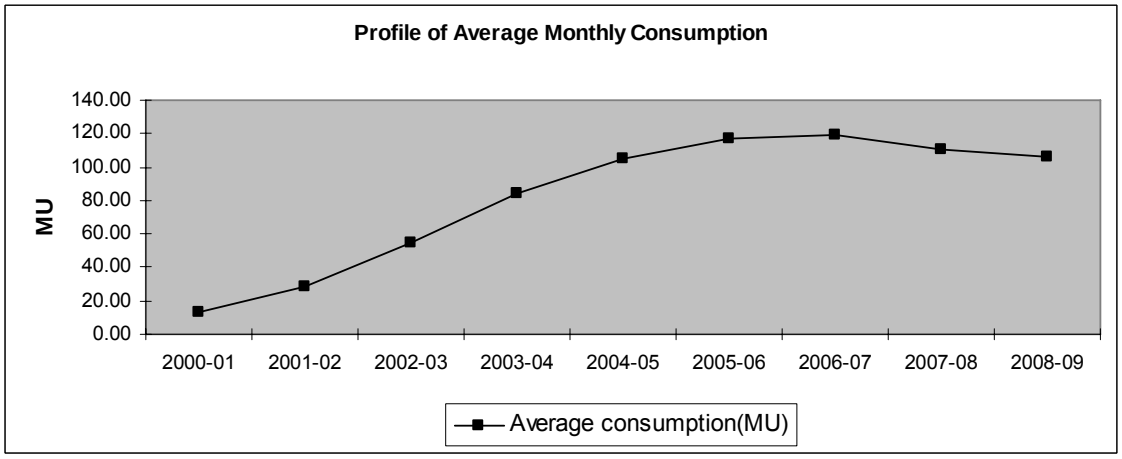


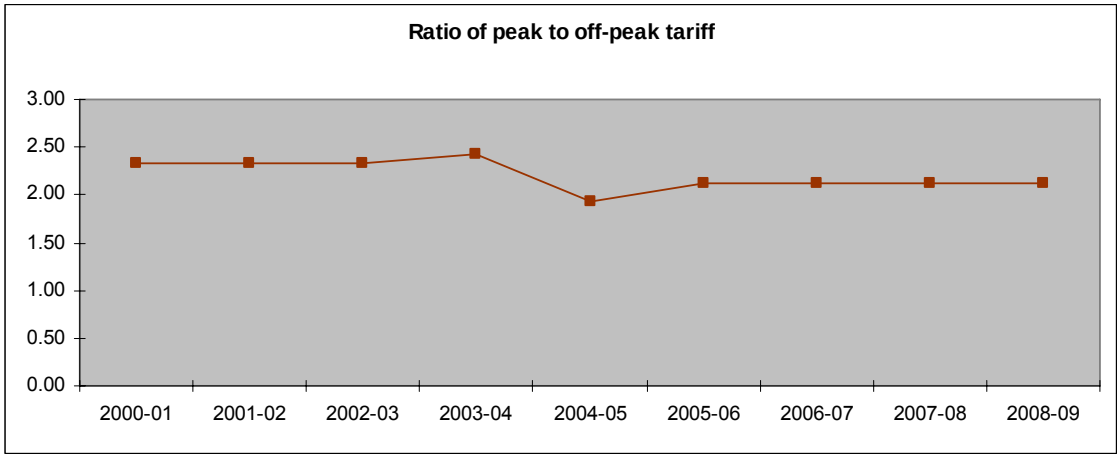

*DPL*

The utility has submitted the month wise consumption data only for each year with respect to the consumer categories covered under TOD tariff. The utility has not submitted hourly consumption data for the consumer categories, due to which respective consumer categories load profile cannot be drawn.

The analysis of the yearly consumption for the major consumer segments of the utility covered under TOD tariff is depicted as under:

- 11 kV industries: The average monthly consumption for the consumer category initially has increased till 2006-07 which can be clearly attributed to the growth in the number of consumers/ load and since 2006-07 there has been a declining trend.

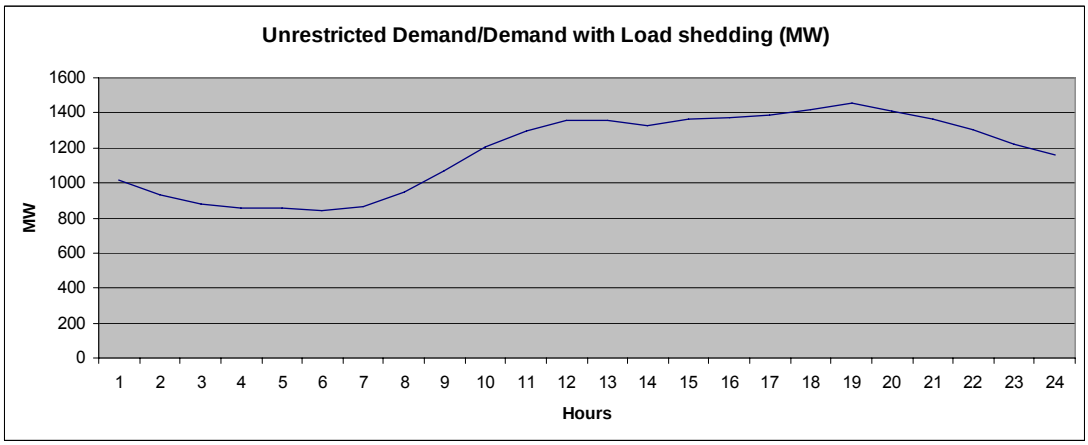





- The analysis of the profile of differential tariff between peak and off-peak for HT industries reveals that in initial years the tariff differential was more as compared to the tariff differential in recent years. However no conclusion can be drawn on the impact of the TOD tariff on the HT industries in the absence of data on peak demand.
- With respect to other consumer categories only the consumption data has been provided for FY 2008-09, hence impact analysis of the peak to off peak tariff differential cannot be carried out.

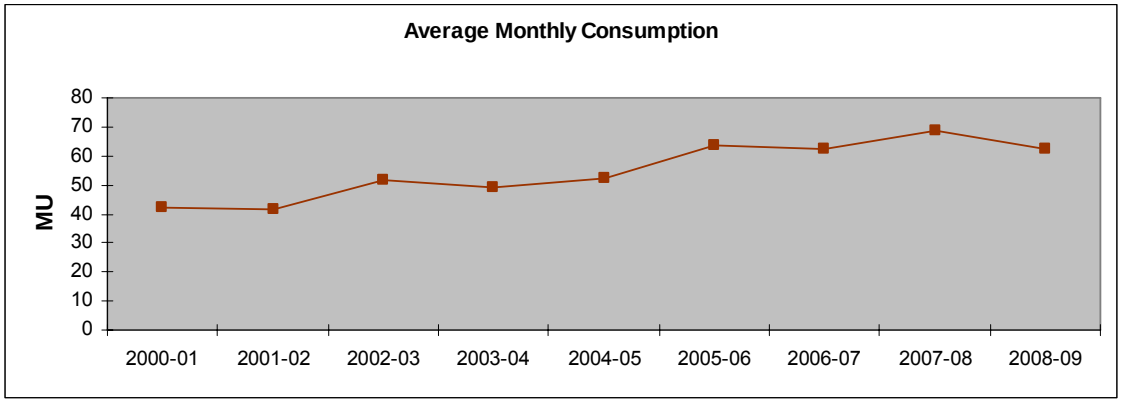
*CESC*

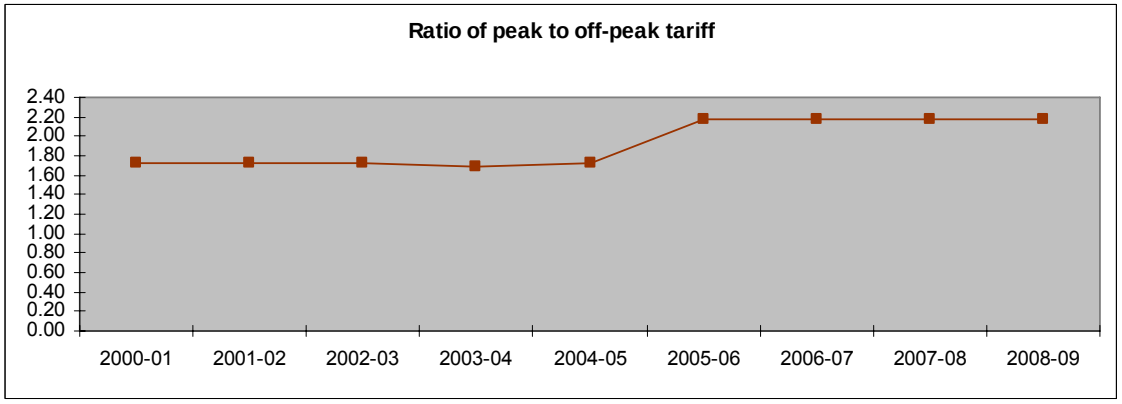
Based on the data submitted by the utility the load profile of the utility for maximum demand day in FY 2008-09 reveals that there is a dip in the load of the utility's system in the tariff period 0000-0900 hrs.




The analysis of the average yearly consumption for the major consumer segments covered under TOD tariff and ratio of peak to off-peak tariff is depicted as under:

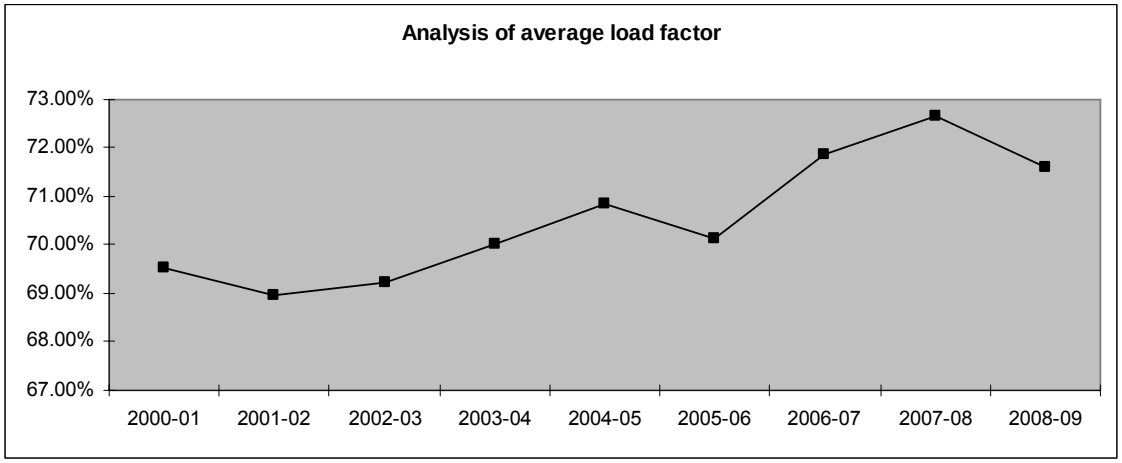
- 11 kV industries: The average monthly consumption for this particular consumer category has shown a declining trend only in the recent year.



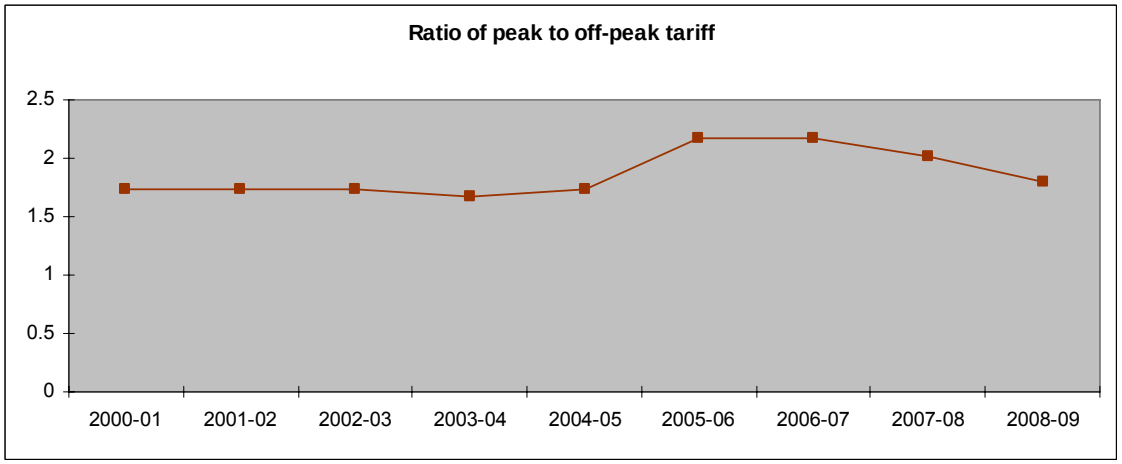




- The ratio of peak to off-peak tariff for 11 kV industries has shown an increase since FY2000-01. However in the absence of information on load factor for the 11 kV industry, impact of tariff differential cannot be ascertained.

The analysis of the average monthly load factor for the utility's system vis-a-vis the tariff differential between peak and off-peak tariff does not indicate direct effect of improvement in the system load factor as a result of increase in tariff differential between peak and of-peak tariff. The system load factor has ranged from 68.96% to 72.67% during the period under study. As can be seen from the figure below there was an improvement in the system load profile during FY2006-07 as well as in 2007-08. It is pertinent to note that In FY 2006-07 the TOD scheme was extended to consumer categories such as LT Commercial & Industrial, HT Commercial and in FY2007-08, TOD tariff scheme was also made applicable to HT Construction power supply (compulsory TOD) and Short term supply(compulsory TOD).



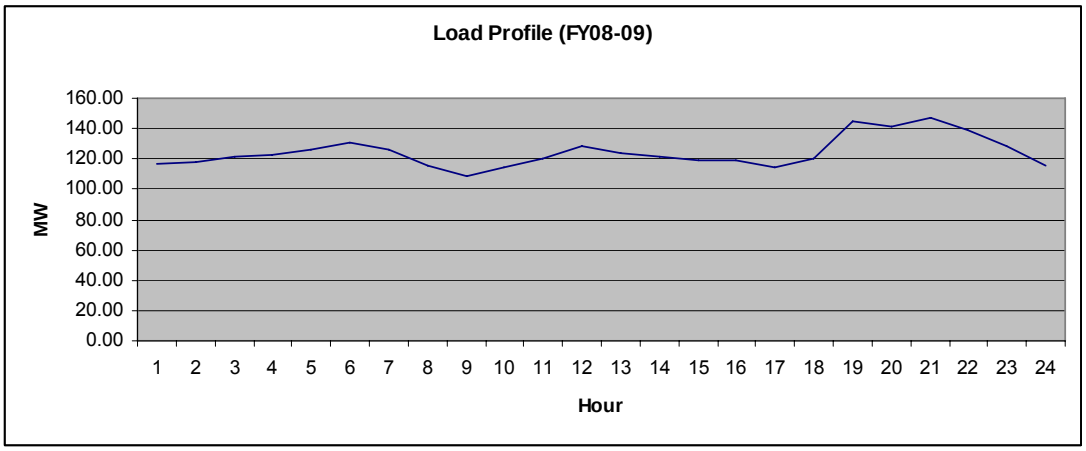

The ratio of peak to off-peak tariff as determined for all consumer categories in the state has declined in recent past due to extension of TOD scheme optional / compulsory to other consumer categories since 2006-07.



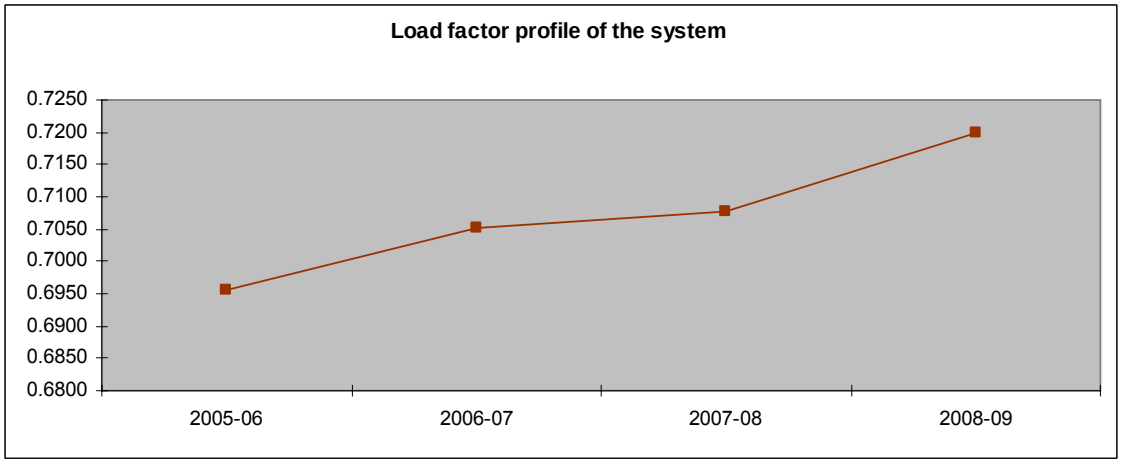

*DPSCL*

Utility has submitted data from FY2005-06 onwards. The data submitted by the utility does not contain any category-wise hourly consumption.

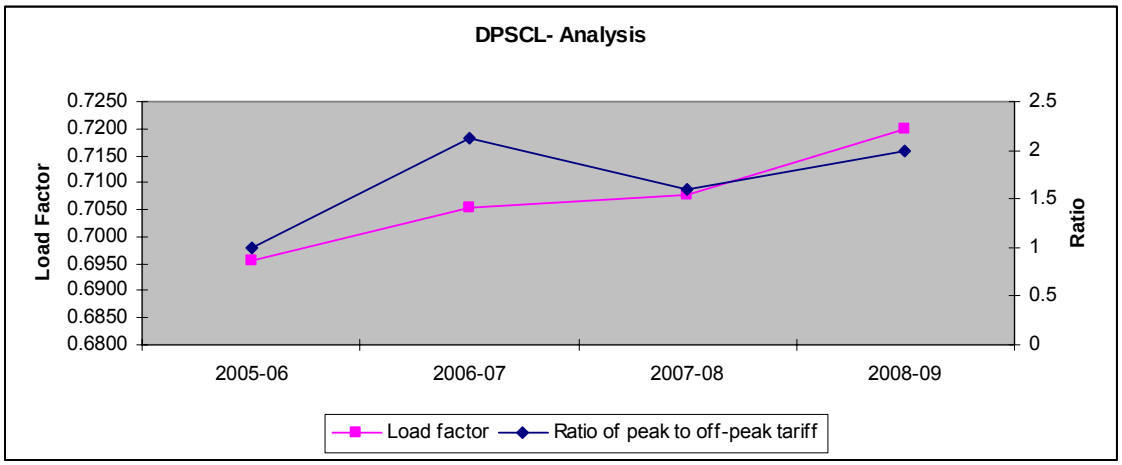
Based on the analysis of the data submitted by the utility the load profile of the system under DPSCL for the maximum demand day is plotted in the figure below, which reveals that the utility has a peak period in the time period (1800 hrs -2300 hrs) and off-peak period between (0700 hrs-0900hrs).




The analysis of the load factor profile of the system reveals that the utility's system load factor has shown an year on year improvement since the year 2005-06, when TOD was not applicable.




The analysis of the load factor profile of the system vis-à-vis tariff differential between peak and off-peak tariff reveals that there is a direct correlation between the increase in the tariff differential between peak and off-peak tariff and the improvement in system load factor, with the exception in year FY2007-08 where the ratio of peak to off-peak tariff has gone down since the TOD tariff was introduced to other consumer categories too, and the average tariff peak and off-peak across consumer categories has been considered for the analysis.




### Conclusion

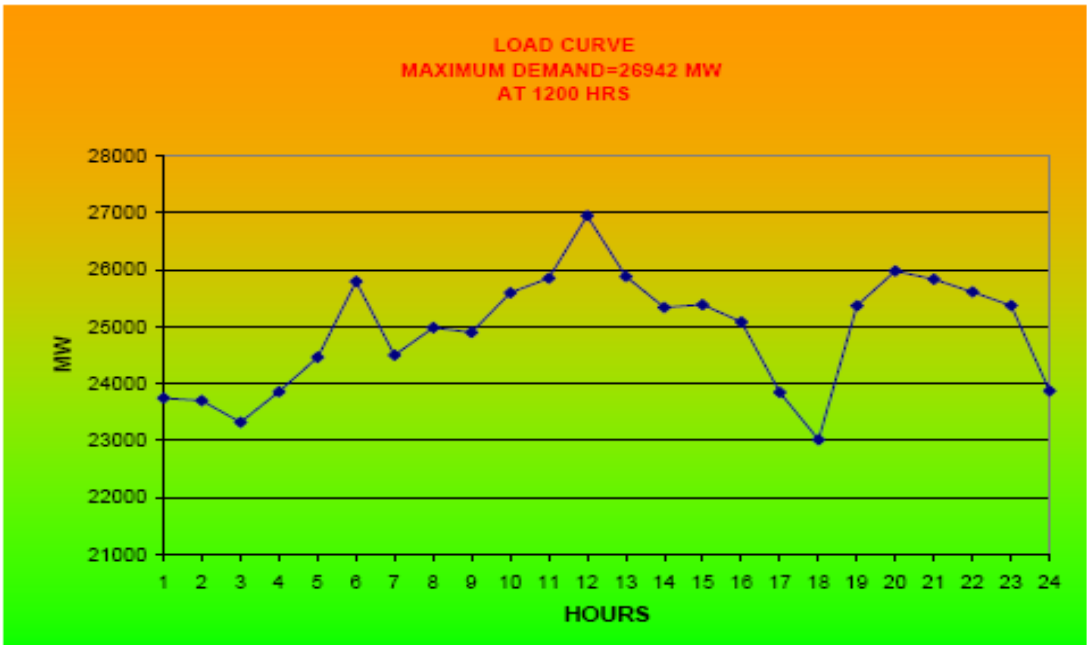
TOD tariff has been extended to other consumer categories in the recent past; however the positive impact of TOD tariff for the state cannot be ascertained due to increasing demand – supply gap in recent years. Further WBSEDCL has not submitted any information on TOD for the study.

However based on the analysis of the data submitted by the other distribution licensees (DPL, DPSCL, CESC) it is observed increasing tariff differential between peak and of-peak hours has a positive impact on the system load factor. It is also observed that extension of TOD tariff to other consumer categories also has a positive impact on the licensee's system load factor.

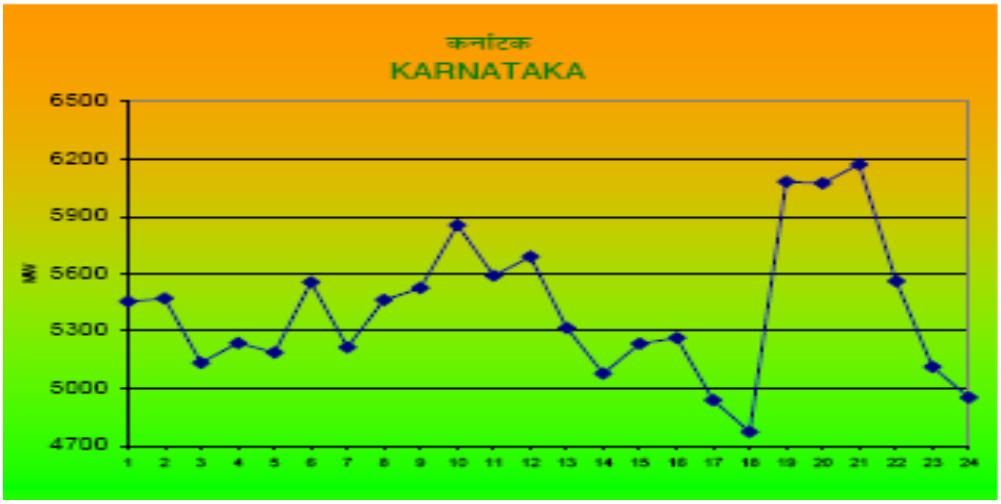
## Karnataka

### Load profile of southern region

Based on the analyses of the load profile of the state it is observed that the state's load profile is similar to that of the Regional load profile, hence it is all the more imperative to introduce DSM measures to curtail the peak demand in the state as well as in the system.




*Load curve of southern region[4] on maximum demand day FY 2008-09*

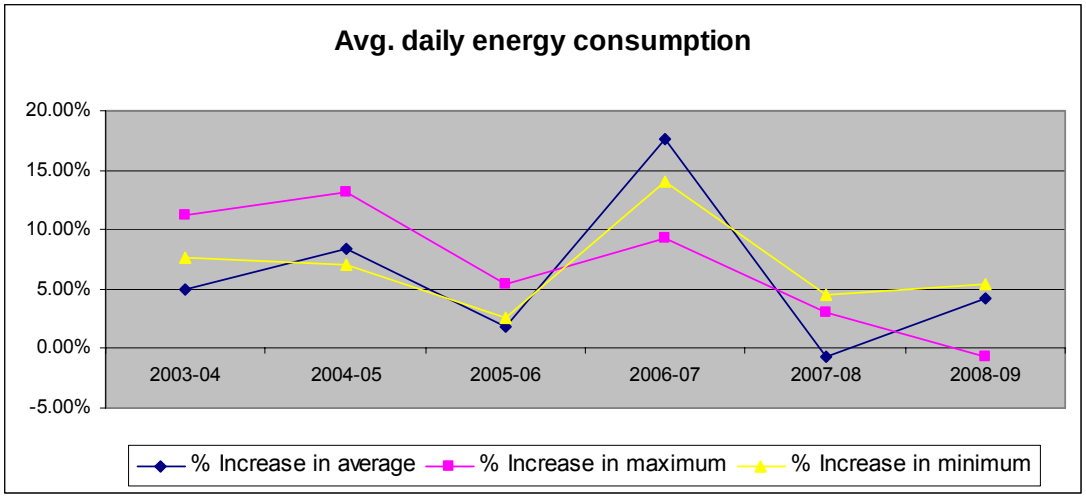



*Hourly load curve of Karnataka [5] on maximum demand day*

The analysis of the data with respect to the month-wise average daily energy consumption for the state as obtained from SRLDC reflects that there has been steady increase in the average daily energy consumption of the state from 2002-03 to 2008-09. However the percentage increase in maximum average month-wise daily energy consumption of a year reflects a decreasing trend in the annual percentage increases since FY 2006-07, which can be inferred to have been due to the positive effect of DSM measures such as introduction of optional TOD tariff in the state since FY 2005-06.

[4] Source: SRPC Annual report

[5] Source: SRPC Annual report



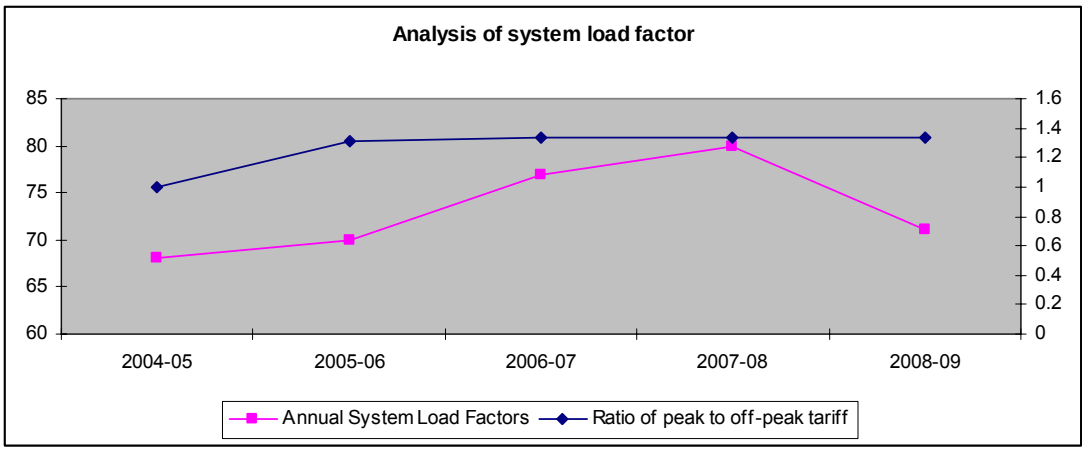

*Trend for energy consumption*

### Data from utilities

The state has introduced optional TOD scheme for the consumers since 2005-06.

Three Discoms have submitted partial data with respect TOD, in which the information with respect to the system demand and consumption for FY 2008-09 only has been provided along with the information on the number of TOD meters installed by the consumers.

Considering that the utilities in the state have not submitted the data based on which the impact of TOD tariff can be analysed, the analysis of the state load factor has been done vis-à-vis the tariff differential between peak and off-peak tariff. The system load factor has improved with the slight increase in tariff differential between peak and off-peak tariff with the exception in FY 2008-09, which shows that introduction of TOD tariff among other measures, has had a positive effect in improving the system load profile.




### Conclusion

The positive impact of TOD as a DSM measure on the system in the state is reflected in the percentage increase in maximum average month-wise daily energy consumption of a year which reveals a decreasing trend in the annual percentage increases since FY 2006-07

However in the absence of consumer category wise TOD information from other utilities in the state, the impact of TOD at consumer level cannot be ascertained.

**Overall conclusion**

Based on the analysis carried of the data on TOD submitted by the utilities and the secondary data the following conclusion can be drawn from the analysis:

- The positive impact of TOD as one of the DSM measures on the overall state system has been seen to a certain extent in all the states except in case of UP.
- In the scenario of gap between demand and supply the system load profile is being maintained by the utilities through the load shedding.
- Based on the analysis carried out it is observed that there is a positive impact on the system load profile with the increasing tariff differential between peak and off-peak tariff.
- It is observed from the analysis of the information supplied by the distribution licensees in West Bengal and data form TPC-D that extension of TOD to other consumer categories/ introduction of compulsory TOD instead of optional TOD tariff has had a positive impact on the licensee's system load factor.
- Utilities in all the selected states have not recorded consumer category wise hourly load profile based on which the end consumer load profile analysis could have been carried out to analyse the impact of TOD tariff at consumer level, this is also one of the constraints which has been highlighted by the respective SERCs (UP, Assam) in their inability to extend TOD tariff to other consumer categories.
- Based on the analysis of the data submitted by the utilities in the selected states it is observed that the monthly reporting formats with respect to that of MSEDCL are comparatively better for monitoring the implementation of TOD. (Refer Annexure-II)

## 4. Cost benefit analysis

### Cost of TOD metering

The utilities in the selected states were asked to furnish details about the TOD metering status as well as the cost involved in implementation of the TOD metering through a questionnaire.

Only one utility has furnished information about the TOD meters and the cost of installing TOD meters. The same has been discussed in the subsequent sections.

In order to facilitate the utilities in various states to carry out cost benefit analysis of implementing TOD metering, a framework for undertaking cost benefit has also been discussed in this section.

#### Maharashtra

TPC-D has provided the following details with respect to the TOD meters installed and the cost involved in their installation:

| Consumer categories | Number of TOD meters installed | Cost incurred (Rs Lakhs) |
|---|---|---|
| LT II (a) Commercial (< 20kW); and<br>LT II (b) Commercial (>20 kW &<50 kW); and<br>LT II (c) (>50 kW) | 2671 | 96 |
| LT III–Industries (Below 20 kW) & LT IV -Industrial (>20 kW) | 1645 | 59 |
| HT I –Industries & CPP | 38 | 2 |
| HT II–Commercial | 65 | 3 |
| HT III–Public & Govt. | 13 | 1 |
| **Total** | **4432** | **160** |

The total cost incurred in the installation of TOD meters as furnished in the table above has been arrived at by considering the cost of a LT meter as Rs 3600 approximately and the cost of a HT meter as Rs 4200 approximately.

However the item-wise cost data of Mahadiscom, Mahagenco and Mahatransco for FY 2008-09, puts the cost of an HT TOD meter at Rs 5300 approx.

Further based on the interaction with the utilities it has been observed that the cost of a HT TOD meter lies in the range of Rs 5200-5500.

### Framework for undertaking cost benefit analysis of TOD metering

In order to assist utilities to undertake the cost benefit analysis of implementing TOD metering, the subsequent section deals with the framework for undertaking such an analysis.

If Utility implements TOD for certain category of consumers, it is likely to result in reduction in consumption during peak hours. The cost benefit analysis can be worked out based on following:

*Benefits*

Following are the benefits which would accrue to the utility upon implementation of TOD metering:

- Additional revenue on account of TOD surcharge during peak hours
- Reduction in cost of power purchase due to reduction in peak consumption

- Revenue gain due to increase in sales during normal hours (shifting of load from peak hours to normal hours)
- Optimization/ reduction in the capex requirement of the utility for network augmentation

*Cost*

The cost involved in implementation of TOD metering are:

- Cost of TOD metering (including implementation)
- Revenue loss due to reduction in sales during peak hours (after introduction of TOD Tariff)

### Input Data

The following inputs would have to be considered in the analysis:

- T&D losses
- Weighted average cost of power purchase
- Average cost of the TOD meter for LT/HT consumer
- Bank PLR

### Assumptions

The following assumptions would have to be taken in the analysis:

- Due to TOD tariff, consumers who reduce their consumption during peak hours will shift 50% (average) of this consumption to other time of the day. For example, a consumer who consumes 100 units during peak hours in existing scenario reduces his consumption by 20 units during peak hours when TOD is implemented, and increases his consumption by 10 units during normal hours as a conservation measure on account of commercial implications. (Note: The extent of shifting of load from peak hours to normal hours may be high in case of industrial consumers, medium in case of domestic consumers and low in case of commercial consumers];
- Reduction in energy supplied during peak hours is purchased from outside sources (Costly power) at a certain paisa/kWh;
- Consumption pattern of selected consumer categories is same throughout the year;
- Life of TOD meters is 10 years;
- Number of consumers, connected load and consumption remains constant for future years for the purpose of this analysis.

### Methodology

The following methodology is suggested for the analysis:

a. Compute the MW load during peak hours assuming various probable values of load factor (LF) during peak hours:

*MW load during peak ($MW_{PL}$) = Load Factor (LF) x Total Connected Load*

b. Compute actual load relief (in MW) achieved during peak hours by implementing TOD tariff based on various probable values of load relief factor (LRF):

*MW load relief during peak ($MW_{LR}$) = Load Relief Factor (LRF) x $MW_{PL}$*

c. Calculate peak hour energy surcharge per kWh (TOD surcharge in absolute term):

Energy *surcharge ($E_S$) in paise/kWh = Rate of TOD surcharge x Nominal energy charge ($E_N$) in paise/kWh*

d. Calculate additional revenue on account of TOD surcharge after implementation of TOD tariff:

*Additional Revenue ($R_A$) (in Rs.) = ($E_S$ / 100) x ($MW_{PL}$ - $MW_{LR}$) x (No of Peak Hours) x 365 x 1000*

e. Calculate revenue loss due to reduced sales during peak hours on account of TOD tariff:

*Revenue Loss ($R_L$) (in Rs.) = ($E_N$ / 100) x ($MW_{LR}$) x (No of Peak Hours) x 365 x 1000*

f. Calculate revenue gain due to increased sales during normal hours on account of TOD tariff:

*Revenue Gain ($R_G$) (in Rs.) = 0.5 x ($E_N$ / 100) x ($MW_{LR}$) x (No of Peak Hours) x 365 x 1000*

g. Calculate effective power purchase rate of costly power at consumer end considering T&D losses:

*Effective Power Purchase Rate ($PP_E$) = Rate of Costly Power Purchased in Peak Hours / [1- (T&D losses in %)]*

h. Calculate saving in power purchase cost due to reduction in sales on account of TOD surcharge:

*Saving in power purchase cost ($S_P$) (in Rs.) = ($PP_E$ / 100) x (0.5 x $MW_{LR}$) x (No of Peak Hours) x 365 x 1000*

i. Calculate net gain/loss due to additional revenue (TOD surcharge during peak hours), revenue loss (reduction in peak hour sales), revenue gain (increase in normal hour sales) and saving in power purchase cost (reduction in peak hour sales):

*Net Gain (+)/Loss(-) (NGL) (in Rs.) = ($R_A$) - ($R_L$) + ($R_G$) + ($S_P$)*

j. Calculate total cost of new TOD metering system (including implementation cost):

*Total Cost* of *Metering ($C_M$) (in Rs.) = Cost of each Meter x No. of Consumers to be covered*

k. Calculate payback period (in years) using values from Step i and j.

## 5. Recommendations & Way forward

### Recommendations

A typical all India demand curve shows that there are typically two periods of the day when the demand is at its peak; one in the morning of about 2 hours duration and another in the evening of about 4 hour duration. Based on further analysis of the regional peak demand taking into consideration the effect of load shedding, following time bands for peak and off-peak periods is suggested:

| Region | Summer season | | Winter season | |
|---|---|---|---|---|
| | Peak Hours | Off-peak Hours | Peak Hours | Off-peak Hours |
| Northern Region | 2000-0000, 1200-1400 | 0000-0600 | 1800-2200, 0600-0800 | 0000-0600 |
| Western Region | 1800-0000 | 0000-0600 | 1800-0000 | 0000-0600 |
| Eastern Region | 1700-2300 | 0000-0600 | 1700-2300 | 0000-0600 |
| North East Region | 1700-2300 | 0000-0600 | 1700-2300 | 0000-0600 |
| Southern Region | 0600-0800, 1900-2300 | 0000-0600 | 0600-0800, 1900-2300 | 0000-0600 |

It is suggested that the State Commissions may specify the peak hours and off-peak hours taking into consideration the local seasonal conditions.

The following structure of Time of Day Tariff is suggested:

a. Structured across 3 slabs: Normal, peak and off-peak

b. Peak Tariff @ 20% - 30% higher than normal tariff

c. Off peak @ 15% - 20% lower than normal tariff

Introduction of TOD tariff in a phased manner is suggested over the next 5 years shown as under:

a. Phase I: Compulsory for HT Consumers

b. Phase II: Compulsory for LT Consumers more than 25 KW

c. Phase III: Compulsory for LT Consumers more than 10 KW

### Introduction of TOD tariff for Domestic and other LT consumers

In order to introduce the TOD tariff to Domestic and other LT consumer categories it is important to test the impact of varying prices on their electricity consumption patterns for which the following methodology is proposed:

- Selection of a sample of consumers for the experimental study
- Setting the experimental TOD tariff which could be neutral compared to the base tariff, i.e., no increase in electricity bill for an “average” consumer who do not change consumption profile.
- Setting the TOD structure (time bands) around system demand peaks.
- Measuring price elasticity of demand i.e. the extent to which individual customers reduce/shift load in response to the set TOD tariff.

Based on the results of the demand–price elasticity, cost benefit analysis as per the framework defined in Chapter 4 can be carried out.

### Steps for increasing penetration of TOD tariffs in existing consumer categories

TOD tariff structure must be defined according to historical and provisional data on demand. This process can be described in two sequential and interrelated steps.

The first step is the choice of the distribution of the hours across the various pricing periods. This must be based on information over the systemic load profile, whose knowledge allows separating higher and lower demand periods. The system load may be typically higher during certain hours within a day, during working days, or during certain seasons; a TOD structure must firstly define the desired direction for incentives to hourly, weekly or seasonal consumption shifts.

The second step is to define the degree of price differentiation across time periods. The choice of price levels requires information on the cost structure of the utility.

Another key parameter is the demand price elasticity, whose knowledge would allow predicting the modifications on the load distribution across time, induced by different tariff structures. If for example price elasticity was 0, the introduction of a TOD cost reflective tariff would be completely ineffective as a demand policy, since it would not produce any modification on the system load profile.

### Methodology of setting TOD tariffs

The SERCs could follow a systematic approach towards setting the TOD tariff outlined as under:

- Identification of system peak period and off-peak period, through the analysis of the system load curve to devise the TOD structure (time bands);
- Proper load profiling of the consumer categories for which TOD is slated to be introduced, through installation of proper meters;
- Estimation of the load shifting through the use of different tariff differentials through a study on sample consumers;
- Introducing an initial TOD tariff which could be set described as under-

  Compute the initial TOD tariffs at a level that makes the revenue estimate same for both the base tariffs and under TOD tariffs. Since the calculation of these tariffs is dependant upon the consumption during each of the time periods, an assumption shall have to be made to start with on the number of consumers who would opt for TOD tariff. In computing TOD tariff set the off peak charges as certain percentage of the base tariff. The charge for consumption during peak period can then be set at a level that fully recovers the revenue from base tariffs.
- Analysis of the impact of the TOD tariff to be done by the utility through the load research on the consumer categories for which TOD is introduced after one year of introduction of TOD tariff; and
- Modification of the TOD tariff/structure in terms of the following-
  - (i). Time bands
  - (ii). Peak and Off-peak tariff
  - (iii). Optional/ compulsory

The above process is an iterative process which needs to be followed by the SERCs.

During the entire process of setting up the TOD tariff the utilities should be directed to make efforts to educate consumers about the benefits of TOD tariff and the potential savings resulting through the shifting of load from peak to off-peak period.

### Methodology of monitoring the impact of TOD tariffs

The entire process of setting the TOD tariff is an iterative process, which requires periodic monitoring in order to ensure the effectiveness of its implementation. The following steps are suggested for monitoring the impact of TOD tariffs:

- Pre-requisites for the study –It is emphasized that the same set of consumers should be monitored before and after the implementation of TOD tariff for proper monitoring. In case segregated feeders are available then on a sample basis select feeders should be put under monitoring for recording the details. In cases where segregated feeders are not available then the feeders can be selected as representing a particular consumer category in case more than 80% of revenue collected from such feeder comes from the particular consumer category.
- The utilities should be directed to conduct load research study for the consumer categories for which TOD has to be introduced before introduction of TOD tariff on a periodic basis and after introduction of TOD Tariff. The study should include the analysis of the following:
  - (i). Analysis of the peak demand, unrestricted demand, and demand met;
  - (ii). Recording of the hourly consumer category load profile
- Utilities should be directed to file annual report w. r. t each consumer category for which TOD is applicable covering the following details for each month:
  - (i). No. of consumers
  - (ii). No. of TOD meters installed
  - (iii). Percentage of consumers covered by TOD meters
  - (iv). Consumption recorded in each time block (peak, off-peak period, normal) by the TOD meters
  - (v). Total consumption recorded in TOD meters
  - (vi). Plot of the load curve for a particular day in a month for the year.

**Way Forward**

Applying advanced communication technologies to metering shall be the driving force behind proper deployment and enhancing penetration of TOD programs in the near future. With communicating TOD meters connected to cost-effective communication systems, favourable economics can be achieved by the utilities. Through remote communications, a less complex and therefore more reliable TOD metering solution can be developed to address the equipment, reading, and maintenance costs associated with standalone TOD metering solutions.

The utilities should try to develop and extend the TOD metering infrastructure in an integrated manner taking into consideration the metering companion standards as considered in R-APDRP, under which all the meters which will be installed shall also have TOD compatibility feature.

The regulators can look forward to introducing differential time of day tariffs for generation also. The present system of uniform generation tariff around the clock is essentially suitable for base-load stations. The present regulatory structure has been able to provide viable long-term generation tariffs mainly through the competitive tariff-based bidding route. However the consumer requires power for meeting both the base load as well as the peaking load. In order to see the development of a proper market response for peaking power supply then it is necessary for the appropriate market signals to be generated with separate procurement contracts for peaking power supply. The consequent impact of differential time-of-day generation tariff contracts would be felt through fresh investment in generation plants for peaking power, which would help in mitigating the peaking power shortages for such consumers who are willing to pay for uninterrupted power supply.

FOR has formulated Model DSM regulations, since most of the SERCs have introduced TOD as DSM measure, hence as a part of effective implementation of DSM measures the regulators can prescribe target reduction of energy consumption under each of the DSM measures which the utility's/licensees should strive to achieve over the stipulated period wherein the entire capex incurred under each of DSM schemes after prudence check by the Commission could be allowed as a pass through in the Annual Revenue Requirement of the utility/licensee.

# ANNEXURE -I

**Objective of seeking the information**

Forum of Regulators (FOR) has engaged M/s PricewaterhouseCoopers Private Limited as consultants for the study on “Assignment on Implementation & Impact Analysis of Time of Day (TOD) tariff in India”.

As a part of the assignment the consultants have to come out with a detailed analysis on TOD for the following five (5) states, which have been selected in consultation with FOR Secretariat:

- Maharashtra
- West Bengal
- Assam
- Karnataka
- Uttar Pradesh

Detailed study on the selected five states shall cover the following:

- Analysis of the impact on peak and energy shortages after implementation of TOD
- Analysis of end-user’s load profile before and after the TOD tariff depicting the usage patterns of the consumer categories for which TOD tariff has been introduced.
- Status of TOD metering in the states and the cost incurred in installing the meters

In order to carry out detailed analysis on the impact of TOD, as described above for the selected five (5) states, the information in the format as depicted in Annexure-1 is sought from the respective Distribution Utilities and the respective State Load Despatch Centre/ State Transmission Utility within 2 weeks.

**Information format**

The following information is required from the distribution utilities in the state:

a. Yearly information required in the following format for the period: One year prior to the introduction of TOD tariff in the state and up to FY 2008-09.

Year

| Month | Monthly actual Peak Demand (MW) | Monthly unrestricted Peak Demand (MW) | Monthly minimum actual demand (MW) | Monthly actual consumption (MU) | Monthly unrestricted requirement (MU) | Monthly average energy consumption (MU) | Load factor | Peak hours specified (hrs) | Off-peak hours specified (hours) |
|---|---|---|---|---|---|---|---|---|---|
| April | | | | | | | | | |
| May | | | | | | | | | |
| June | | | | | | | | | |
| July | | | | | | | | | |
| August | | | | | | | | | |
| September | | | | | | | | | |
| October | | | | | | | | | |
| November | | | | | | | | | |
| December | | | | | | | | | |
| January | | | | | | | | | |
| February | | | | | | | | | |
| March | | | | | | | | | |

b. Yearly information required in the following format for the period: One year prior to the introduction of TOD tariff in the state and up to FY 2008-09:

| Year | State Peak Demand (MW) | State Average Demand met (MW) |
|---|---|---|
| FY | | |
| FY | | |
| FY | | |
| FY | | |
| FY | | |

c. Hourly load data of the state required on:

- Maximum demand day for FY 2008-09 in the following format

| Date/Year _____ / FY | | |
|---|---|---|
| Hour | Actual Demand met (MW) | Unrestricted Demand / Demand with Load shedding (MW) |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |

| Date/Year _____ / FY | | |
|---|---|---|
| Hour | Actual Demand met (MW) | Unrestricted Demand / Demand with Load shedding (MW) |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |

- Minimum demand day for FY 2008-09 in the following format:

| Date/Year _____ / FY | | |
|---|---|---|
| Hour | Actual Demand met (MW) | Unrestricted Demand / Demand with Load shedding(MW) |
| 1 | | |
| 2 | | |
| 3 | | |

Date/Year _____ / FY

| Hour | Actual Demand met (MW) | Unrestricted Demand / Demand with Load shedding(MW) |
|---|---|---|
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |

d. With respect to those consumers for which TOD is applicable the following information is required in the attached format for the period: One (1) year prior to the introduction of TOD tariff in the state and up to FY 2008-09.

| Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Consumer Category | | | | | | | | | | |
| Whether TOD is Optional/ Compulsory | | | | | | | | | | |
| Month | Monthly actual Peak Demand (MW) | Monthly unrestricted Peak Demand (MW) | Monthly minimum actual demand (MW) | Monthly actual consumption (MU) | Monthly unrestricted requirement (MU) | Monthly average energy consumption (MU) | Peak hours specified (hours) | Off-peak hours specified (hours) | Tariff applicable in Peak hours | Tariff applicable in Off-Peak hours |
| April | | | | | | | | | | |
| May | | | | | | | | | | |
| June | | | | | | | | | | |
| July | | | | | | | | | | |
| August | | | | | | | | | | |
| September | | | | | | | | | | |
| October | | | | | | | | | | |
| November | | | | | | | | | | |
| December | | | | | | | | | | |
| January | | | | | | | | | | |
| February | | | | | | | | | | |
| March | | | | | | | | | | |

e. Hourly load data of the consumer categories for which TOD is applicable on:

- State's Maximum demand day for FY 2008-09 in the following format

| Date/Year | _____ /FY | |
|---|---|---|
| Consumer Category | | |
| Hour | Actual Demand met (MW) | Unrestricted Demand / Demand with Load shedding(MW) |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |

| Date/Year | _____ /FY | |
|---|---|---|
| Consumer Category | | |
| Hour | Actual Demand met (MW) | Unrestricted Demand / Demand with Load shedding(MW) |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |

- State's Minimum demand day for FY 2008-09 in the following format

| Date/Year | _____ / FY | |
|---|---|---|
| Consumer Category | | |
| Hour | Actual Demand met (MW) | Unrestricted Demand / Demand with Load shedding(MW) |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |

| Date/Year | _____ / FY | |
|---|---|---|
| Consumer Category | | |
| Hour | Actual Demand met (MW) | Unrestricted Demand / Demand with Load shedding(MW) |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |

f. Status of TOD metering in the state in the following format:

| S. No. | Consumer Categories | Number of TOD meters installed | Cost incurred | Remarks |
|---|---|---|---|---|
| | | | | |
| | | | | |

## Annexure-II

### Monthly reporting format of MSEDCL

The monthly reporting format of MSEDCL, for each of the consumer category for which TOD is applicable is shown as under:

**Consumer Category:-_____**

| S. No. | Month & year | Total consumers (No.) | TOD meters with slot-wise readings (No.) | % of TOD meters to No. of consumers | Total TOD consumption (MU) | Slot-1 units 22:00-06:00 (MU) | Slot-2 units 06:00-09:00 & 12:00-18:00 (MU) | Slot-3 units 09:00-12:00 (MU) | Slot-4 units 18:00-22:00 (MU) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | April | | | | | | | | |
| 2 | May | | | | | | | | |
| 3 | June | | | | | | | | |
| 4 | July | | | | | | | | |
| 5 | August | | | | | | | | |
| 6 | September | | | | | | | | |
| 7 | October | | | | | | | | |
| 8 | November | | | | | | | | |
| 9 | December | | | | | | | | |
| 10 | January | | | | | | | | |
| 11 | February | | | | | | | | |
| 12 | March | | | | | | | | |

## Annexure-III

### Illustration of the cost benefit analysis of TOD tariff to utility

The illustrative study on cost benefit analysis of TOD tariff to utility as discussed in Chapter 4 of this report has been depicted in this section:

The utility taken into consideration for the study is **UPPCL (UP)** and the cost benefit analysis for extending TOD tariff to the following categories of consumers has been projected based on the assumptions on certain parameters:

(a) Small and medium power

(b) Non- domestic consumers

(c) Domestic consumers

### Ist illustration

### Input data

The following input data has been considered:

| S.NO. | Parameters | Unit | Values |
|---|---|---|---|
| 1 | T&D losses (based on the Tariff Order ) | | 21.3% |
| 2 | Weighted average power purchase cost (based on the tariff order) | Rs per unit | 2.67 |
| 3 | Average cost of TOD meter for LT consumer including implementation cost | Rs | 3600 |
| 4 | Bank PLR | per annum | 11.75% |
| 5 | Revenue gain on account of increase in consumption in off-peak period | Rs per unit | 0.5 |
| 6 | Life of TOD meter | year | 10 |

The following data on consumer has been considered for analysis:

| S. No. | Category | Considered for analysis | Total No. of Consumers | Total Connected Load (MW) | Total Sales (MU) | Average Load Factor** | % of Consumers already having TOD Meter* | Base Energy charges | TOD surcharge**** |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Small and medium | Overall | 111436 | 1233.626 | 1612 | 30.00% | 10% | 4.95 | 0.15 |

| S. No. | Category | Considered for analysis | Total No. of Consumers | Total Connected Load (MW) | Total Sales (MU) | Average Load Factor** | % of Consumers already having TOD Meter* | Base Energy charges | TOD surcharge**** |
|---|---|---|---|---|---|---|---|---|---|
| | power | | | | | | | | |
| 2 | Non domestic consumers | Overall | 1031203 | 2278.621 | 2819 | | | | |
| | | > 100 units/month (taken 50% of overall)*** | 515601.5 | 1595.0347 | 1973.3 | 25.00% | 10% | 4.95 | 0.15 |
| 3 | LMV1 (domestic consumers with consumption more than 200 units/month) | Overall | 8452430 | 13736.28 | 15084 | | 1% | | |
| | | > 1000 units/month (taken 5% of Overall)*** | 845.243 | 84.52 | 666.39 | 20% | 2% | 3.8 | 0.15 |

*Source: Tariff Order for FY09-10(UPERC)*

*Assumption considered in absence of actual TOD metering data

** Average load factor considered although it can be based on the actuals

*** Values assumed taking into consideration applicability of TOD on consumers having monthly consumption above a certain threshold

****Assumed as per existing peak tariff for HT consumers in the state

**Load relief factor**: The cost benefit analysis has been based on the following probable values of load relief factor:

| Consumer Category | Load relief factor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Small and Medium power | 5% | 10% | 15% | 20% | 25% | 30% | 35% | 40% | 45% | 50% |
| Non Domestic | 5% | 10% | 15% | 20% | 25% | 30% | 35% | 40% | 45% | 50% |
| Domestic | 5% | 10% | 15% | 20% | 25% | 30% | 35% | 40% | 45% | 50% |

**Load factor:** The three scenarios of the cost benefit analysis have been based on the following probable values of load factor for the consumer categories:

| Consumer category | Case-I (Load factor) | Case-II (Load factor) | Case-III (Load factor) |
|---|---|---|---|

| Consumer category | Case-I (Load factor) | Case-II (Load factor) | Case-III (Load factor) |
|---|---|---|---|
| Small and Medium power | 20% | 40% | 60% |
| Non Domestic | 30% | 50% | 70% |
| Domestic | 20% | 40% | 60% |

**Other assumptions considered in the analysis**

(a) Due to TOD tariff, consumers who reduce their consumption during peak hours (1700-2200) will shift 50% (average) of this consumption to other time of the day.

(b) Additional energy supplied to consumers during peak hours is purchased from outside sources (i.e. weighted average cost of total power purchase by the state)

(c) Consumption pattern of selected consumer categories is same throughout the year

(d) Number of consumers, connected load and consumption remains constant for future years for the purpose of this analysis.

**Results**

**Determination of Payback period in terms of no. of years:**

| CASE-I (LOAD FACTOR: Small and medium power = 20%, COMMERCIAL = 30%, DOMESTIC = 20%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD RELIEF FACTOR (LRF) | 5% | 10% | 15% | 20% | 35% | 30% | 40% | 50% |
| Payback period (years) | 2.8 | 3.9 | 6.3 | 16.1 | - | - | - | - |

| CASE-II (LOAD FACTOR: Small and medium power = 40%, COMMERCIAL = 50%, DOMESTIC = 40%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD RELIEF FACTOR (LRF) | 5% | 10% | 15% | 20% | 35% | 30% | 40% | 50% |
| Payback period (years) | 1.6 | 2.2 | 3.5 | 9.0 | - | - | - | - |

| CASE-III (LOAD FACTOR: Small and medium power = 60%, COMMERCIAL = 70%, DOMESTIC = 60 %) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD RELIEF FACTOR (LRF) | 5% | 10% | 15% | 20% | 35% | 30% | 40% | 50% |
| Payback period (years) | 1.10 | 1.52 | 2.45 | 6.27 | - | - | - | - |

**EFFECT OF SENSITIVITY PARAMETERS ON RESULTS**

The table below summarises the effect of various sensitivity parameters on payback period for the utility under various scenarios- Case-I, Case-II and Case-III:

| CHANGE IN VALUE OF PARAMETER (KEEPING OTHER PARAMETERS CONSTANT) | EFFECT ON PAYBACK PERIOD |
|---|---|
| INCREASE IN LOAD FACTOR | REDUCES |
| INCREASE IN LOAD RELIEF FACTOR | INCREASES |

**IInd illustration**

Considering all other input data same as considered in the Ist lilustration except **weighted average power purchase cost as Rs. 4.50 per unit.**

Keeping all the assumptions identical except:

(a) Due to TOD tariff, consumers who reduce their consumption during peak hours (1700-2200) **will shift 80%** (average) of this consumption to other time of the day.

**Results**

**Determination of Payback period in terms of no. of years:**

| CASE-I (LOAD FACTOR: Small and medium power = 20%, COMMERCIAL = 30%, DOMESTIC = 20%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD RELIEF FACTOR (LRF) | 5% | 10% | 15% | 20% | 35% | 30% | 40% | 50% |
| Payback period (years) | 2.5 | 2.9 | 3.4 | 4.1 | 5.1 | 7.0 | 10.8 | 24.3 |

| CASE-II (LOAD FACTOR: Small and medium power = 40%, COMMERCIAL = 50%, DOMESTIC = 40%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD RELIEF FACTOR (LRF) | 5% | 10% | 15% | 20% | 35% | 30% | 40% | 50% |
| Payback period (years) | 1.4 | 1.6 | 1.9 | 2.3 | 2.9 | 3.9 | 6.1 | 13.6 |

| CASE-III (LOAD FACTOR: Small and medium power = 60%, COMMERCIAL = 70%, DOMESTIC = 60 %) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD RELIEF FACTOR (LRF) | 5% | 10% | 15% | 20% | 35% | 30% | 40% | 50% |
| Payback period (years) | 0.98 | 1.12 | 1.31 | 1.58 | 2.00 | 2.71 | 4.22 | 9.45 |

## Annexure-IV

### International experience

In this section experimental studies carried out to study the response of the consumers to the time of use tariffs across different utilities in various countries has been discussed:

**PUGET SOUND ENERGY (PSE)'S TOU PROGRAM- Washington**

PSE initiated a TOU program for its residential and small commercial customers in 2001. The rate design involved four TOU periods. Electricity prices were most expensive during the morning and evening periods with mid-day and economy periods following these most expensive periods. Some 300,000 PSE customers were placed in the program and given the option to go back to the standard rates if they were not satisfied with the program. The peak price was roughly 15 percent higher than the average price that prevailed before the program and the off-peak price was 15 percent lower.

In 2002, the second year of the program, customers were charged a monthly fee of $1 per month for meter-reading costs. The results of PSE's quarterly report revealed that the 94 percent of the customers paid an extra $0.80 (the total of $0.20 power savings and $1 meter reading costs) by participating in the pilot. This was in contrast with the first year results where customers were not charged meter reading costs and around 55 percent of them experienced bill savings. As a result of customer dissatisfaction and negative media coverage, PSE ceased its TOU program.

Following were the lessons derived from this experience:

- Modest price differentials between peak and off-peak may induce customers to shift their load if they are accompanied with unusual circumstances such as the energy crisis of 2000-2001 in the West.

- An independent analysis of the program found that customers lowered peak usage by 5 percent per month over a 15 month period, with reductions being slightly higher in the winter months and slightly lower in the summer months.

**NEW SOUTH WALES/AUSTRALIA**

The TOU pricing program is the largest demand management project by Energy Australia. Energy Australia started the Strategic Pricing Study in 2005 which included 1,300 voluntary customers (50 percent business, 50 percent residential customers). The study tested seasonal, dynamic, and information only tariffs and involved the use of in-house displays and online access to data. Study participants received dynamic peak price signals through Short Message Service (SMS), telephone, email, or the display unit.

Preliminary results that are available from three dynamic peak pricing (DPP) events show that:

- Residential customers reduced their dynamic peak consumption by roughly 24 percent for DPP high rates (A$2+/kWh) and roughly 20 percent for DPP medium rates (A$1+/kWh).

- Response to the 2nd DPP event was greater than that to the 1st DPP event. This may be attributed to the day-ahead notification under the 2nd DPP event (versus day of notification under the 1st DPP event) and/or temperature differences.

- Response to the 2nd event was also greater than to the 3rd DPP event. This may be explained by lower temperatures on the 3rd DPP event which may have led to less discretionary appliances to turn off.

**CALIFORNIA- STATEWIDE PRICING PILOT**

California's three investor-owned utilities, Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E), together with the two regulatory commissions conducted the Statewide Pricing Pilot (SPP) that ran from July 2003 to December 2004 to test the impact of several time-varying rates. The program included about 2,500 participants including residential and small-to-medium commercial and industrial customers.

Statewide Pricing Pilot program tested several rate structures:

• Time of Use (TOU) only rate where the peak price was twice the value of the off-peak price.

• CPP rate where peak price during the critical days was about five times greater than the off-peak price; on non-critical days, a TOU rate applied. The SPP tested two variations of the CPP rates.

i. CPP-F rate had a fixed period of critical peak and day-ahead notification. Customers did not have an enabling technology.

ii. CPP-V rate had a variable-length of peak duration during critical days and day-of notification. Customers had choice of adopting an enabling technology.

The impacts of the pilot study were:

**TOU:** The average price for customers on the standard rate was about $0.13 per kWh. Under the TOU rate, the average peak-period price was roughly $0.22 per kWh and the average offpeak price was $ 0.09 per kWh.

The reduction in peak period energy use during the inner summer months of 2003 was estimated to be 5.9 percent.

**CPP-F:** The average price for customers on the standard rate was about $0.13 per kWh, the average peak-period price on critical days was roughly $0.59 per kWh, the peak price on non-critical days was $0.22 per kWh, and the average off-peak price was $0.09 per kWh.

- On critical days, statewide average reduction in peak-period energy use was estimated to be 13.1 percent.

- On normal weekdays, the average reduction in peak –demand energy use was 4.7 percent.

**CPP-V:** The average price for customers on standard rate was about $0.14 per kWh, the average peak-period price on critical days was roughly $0.65 per kWh and the average off-peak price was $0.10 per kWh. This tariff was tested on two different groups of customers. Track A customers were drawn from a population with energy use greater than 600kWh per month and they were given a choice of installing an enabling technology and about two thirds of them opted for the enabling technology. Track C group was formed from customers who previously volunteered for a smart thermostat pilot. All Track C customers had central AC and smart thermostats. Thus almost two-thirds of Track A customers and all Track C customers had enabling technologies.

- Track A customers reduced their peak-period energy use on critical days by about 16 percent
- Track C customers reduced their peak-period use on critical days by about 27 percent.

## Annexure-V

TOD tariff applicable in the state for various consumer categories as per Tariff Order of FY2010-11 for WBSEDCL is tabulated as under:

***Low & Medium voltage consumers***

| Type of consumer | Tariff scheme | Optional tariff scheme-I (energy charge- P/Kwh) | | Tariff scheme | Optional tariff scheme-II (energy charge- P/Kwh) | |
|---|---|---|---|---|---|---|
| Commercial rural | Normal TOD | 0600-1700 hrs | 485 | Prepaid TOD | 0600-1700 hrs | 475 |
| | | 1700-2300 hrs | 534 | | 1700-2300 hrs | 523 |
| | | 2300-0600 hrs | 451 | | 2300-0600 hrs | 442 |
| Commercial urban | Normal TOD | 0600-1700 hrs | 485 | Prepaid TOD | 0600-1700 hrs | 475 |
| | | 1700-2300 hrs | 534 | | 1700-2300 hrs | 523 |
| | | 2300-0600 hrs | 451 | | 2300-0600 hrs | 442 |
| Public utility Specified Institution Public Bodies | | | | Prepaid TOD | 0600-1700 hrs; 2000-2300 hrs; | 450 |
| in Municipal areas | | | | | 1700-2000 hrs | 495 |
| in Municipal areas | | | | | 2300-0600 hrs | 418 |
| Public utility Specified Institution Public Bodies | | | | Prepaid TOD | 0600-1700 hrs; 2000-2300 hrs; | 450 |
| in Non-Municipal areas | | | | | 1700-2000 hrs | 495 |
| in Non-Municipal areas | | | | | 2300-0600 hrs | 418 |
| Cottage industry/ Artisan/ Weavers/ Small production oriented establishment in non –municipal areas and not run by electricity as motive | Prepaid TOD | 0600-1700 hrs | 515 | | | |
| | | 1700-2300 hrs | 567 | | | |
| | | 2300-0600 hrs | 479 | | | |
| Poultry, Duckery, Horticulture, Tissue culture, Floriculture, Food processing unit, Herbal medicinal-bio-diesel plant Farming | Prepaid TOD | 0600-1700 hrs | 504 | | | |
| | | 1700-2300 hrs | 554 | | | |
| | | 2300-0600 hrs | 469 | | | |
| Irrigation pumping for agriculture (metered) | Prepaid TOD | 0600-1700 hrs | 218 | | | |
| | | 1700-2300 hrs | 588 | | | |
| | | 2300-0600 hrs | 152 | | | |
| Public water works and Sewerage system | Prepaid TOD | 0600-1700 hrs; 2000-2300 hrs | 448 | | | |
| | | 1700-2000 hrs | 672 | | | |
| | | 2300-0600 hrs | 309 | | | |

| Type of consumer | Tariff scheme | Optional tariff scheme-I (energy charge- P/Kwh) | | Tariff scheme | Optional tariff scheme-II (energy charge- P/Kwh) |
|---|---|---|---|---|---|
| Industry (rural) | Normal TOD | 0600-1700 hrs | 500 | | |
| | | 1700-2300 hrs | 700 | | |
| | | 2300-0600 hrs | 330 | | |
| Industry (urban) | Normal TOD | 0600-1700 hrs | 510 | | |
| | | 1700-2300 hrs | 714 | | |
| | | 2300-0600 hrs | 337 | | |
| Private educational institutions and hospitals | Normal TOD | 0600-1700 hrs; 2000-2300 hrs | 473 | | |
| | | 1700-2000 hrs | 520 | | |
| | | 2300-0600 hrs | 440 | | |
| Bulk supply at single point to CGHS for providing power to its members or person providing power to its employees in a single premises | Normal TOD | 0600-1700 hrs | 460 | | |
| | | 1700-2300 hrs | 506 | | |
| | | 2300-0600 hrs | 420 | | |
| Commercial and industrial consumers (50 kVA and above but upto 125 kVA) | Normal TOD | 0600-1700 hrs; | 530 | | |
| | | 1700-2300 hrs | 682 | | |
| | | 2300-0600 hrs | 393 | | |

### *High & Extra High voltage consumer*

| Type of consumer | Tariff scheme | Applicable tariff scheme (energy charge- P/Kwh) | | | Tariff scheme | Optional tariff scheme- (energy charge- P/Kwh) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Summer | Monsoon | Winter | | | Summer | Monsoon | Winter |
| Public utility (11 kV) | | | | | Normal TOD | 0600-1700 hrs; 2000-2300 hrs | 422 | 420 | 418 |
| | | | | | | 1700-2000 hrs | 562 | 559 | 556 |
| | | | | | | 2300-0600 hrs | 338 | 337 | 336 |
| Public utility (33 kV) | | | | | Normal TOD | 0600-1700 hrs; 2000-2300 hrs | 415 | 413 | 411 |
| | | | | | | 1700-2000 hrs | 552 | 549 | 546 |
| | | | | | | 2300-0600 hrs | 333 | 331 | 330 |
| Industries | | | | | Normal | 0600-1700 hrs; 2000- | 531 | 530 | 529 |

| Type of consumer | Tariff scheme | Applicable tariff scheme (energy charge- P/Kwh) | | | | Tariff scheme | Optional tariff scheme- (energy charge- P/Kwh) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Summer | Monsoon | Winter | | | Summer | Monsoon | Winter |
| (11 kV) | | | | | | TOD | 2300 hrs | | | |
| | | | | | | | 1700-2000 hrs | 683 | 682 | 681 |
| | | | | | | | 2300-0600 hrs | 394 | 393 | 392 |
| Industries (33 kV) | | | | | | Normal TOD | 0600-1700 hrs; 2000-2300 hrs | 503 | 501 | 499 |
| | | | | | | | 1700-2000 hrs | 644 | 641 | 638 |
| | | | | | | | 2300-0600 hrs | 376 | 375 | 373 |
| Industries (132 kV) | | | | | | Normal TOD | 0600-1700 hrs; 2000-2300 hrs | 492 | 490 | 488 |
| | | | | | | | 1700-2000 hrs | 629 | 626 | 623 |
| | | | | | | | 2300-0600 hrs | 369 | 367 | 366 |
| Industries (220 kV) | Normal | 0600-1700 hrs | 450 | 448 | 446 | | | | | |
| | | 1700-2300 hrs | 570 | 567 | 564 | | | | | |
| | | 2300-0600 hrs | 347 | 346 | 345 | | | | | |
| Industries (400 kV) | Normal | 0600-1700 hrs | 445 | 443 | 441 | | | | | |
| | | 1700-2300 hrs | 563 | 560 | 557 | | | | | |
| | | 2300-0600 hrs | 344 | 343 | 342 | | | | | |
| Community irrigation/Irrigation | Normal TOD | 0600-1700 hrs | 450 | 448 | 449 | | | | | |
| | | 1700-2300 hrs | 600 | 597 | 599 | | | | | |
| | | 2300-0600 | 300 | 298 | 299 | | | | | |

| Type of consumer | Tariff scheme | Applicable tariff scheme (energy charge- P/Kwh) | | | | Tariff scheme | Optional tariff scheme- (energy charge- P/Kwh) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Summer | Monsoon | Winter | | | Summer | Monsoon | Winter |
| | | hrs | | | | | | | | |
| Commercial plantaton | Normal TOD | 0600-1700 hrs | 536 | 534 | 532 | | | | | |
| | | 1700-2300 hrs | 690 | 687 | 684 | | | | | |
| | | 2300-0600 hrs | 405 | 404 | 403 | | | | | |
| Short term irrigation supply | Normal TOD | 0600-1700 hrs | 505 | 501 | 503 | | | | | |
| | | 1700-2300 hrs | 712 | 706 | 709 | | | | | |
| | | 2300-0600 hrs | 328 | 326 | 327 | | | | | |
| Short term supply for commercial plantation | Normal TOD | 0600-1700 hrs | 550 | 548 | 546 | | | | | |
| | | 1700-2300 hrs | 710 | 707 | 704 | | | | | |
| | | 2300-0600 hrs | 414 | 413 | 412 | | | | | |
| Commercial (11 kV) | | | | | | Normal TOD | 0600-1700 hrs | 543 | 541 | 539 |
| | | | | | | | 1700-2300 hrs | 740 | 737 | 734 |
| | | | | | | | 2300-0600 hrs | 421 | 419 | 417 |
| Commercial (33 kV) | | | | | | Normal TOD | 0600-1700 hrs | 521 | 520 | 519 |
| | | | | | | | 1700-2300 hrs | 707 | 706 | 704 |
| | | | | | | | 2300-0600 hrs | 406 | 405 | 404 |
| Commercial (132 kV) | | | | | | Normal TOD | 0600-1700 hrs | 505 | 503 | 501 |
| | | | | | | | 1700-2300 hrs | 547 | 545 | 543 |
| | | | | | | | 2300-0600 | 384 | 382 | 380 |

| Type of consumer | Tariff scheme | Applicable tariff scheme (energy charge- P/Kwh) | | | | Tariff scheme | Optional tariff scheme- (energy charge- P/Kwh) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Summer | Monsoon | Winter | | | Summer | Monsoon | Winter |
| | | | | | | | hrs | | | |
| Domestic | | | | | | Normal TOD | 0600-1700 hrs | 520 | 518 | 516 |
| | | | | | | | 1700-2300 hrs | 557 | 555 | 553 |
| | | | | | | | 2300-0600 hrs | 494 | 496 | 494 |
| Public Water Works & Sewerage (11 kV) | | | | | | Normal TOD | 0600-1700 hrs; 2000-2300 hrs | 425 | 423 | 421 |
| | | | | | | | 1700-2000 hrs | 567 | 564 | 561 |
| | | | | | | | 2300-0600 hrs | 340 | 339 | 338 |
| Public Water Works & Sewerage (33 kV) | | | | | | Normal TOD | 0600-1700 hrs; 2000-2300 hrs | 420 | 418 | 416 |
| | | | | | | | 1700-2000 hrs | 560 | 557 | 554 |
| | | | | | | | 2300-0600 hrs | 336 | 334 | 332 |
| Cold storage or Dairies with chilling plant(11kV) | | | | | | Normal TOD | 0600-1700 hrs | 417 | 416 | 415 |
| | | | | | | | 1700-2300 hrs | 524 | 523 | 521 |
| | | | | | | | 2300-0600 hrs | 326 | 325 | 324 |
| Emergency supply | Normal TOD | 0600-1700 hrs | 535 | 533 | 531 | | | | | |
| | | 1700-2300 hrs | 689 | 686 | 683 | | | | | |
| | | 2300-0600 hrs | 405 | 403 | 401 | | | | | |
| Construction power suppply | Normal TOD | 0600-1700 hrs | 550 | 548 | 546 | | | | | |
| | | 1700-2300 hrs | 710 | 707 | 704 | | | | | |
| | | 2300-0600 hrs | 414 | 412 | 410 | | | | | |

| Type of consumer | Tariff scheme | Applicable tariff scheme (energy charge- P/Kwh) | | | | Tariff scheme | Optional tariff scheme- (energy charge- P/Kwh) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Summer | Monsoon | Winter | | | Summer | Monsoon | Winter |
| Bulk supply at single point to CGHS for providing power to its members or person providing power to its employees in a single premises | Normal TOD | 0600-1700 hrs | 495 | 493 | 491 | | | | | |
| | | 1700-2300 hrs | 530 | 527 | 525 | | | | | |
| | | 2300-0600 hrs | 471 | 469 | 467 | | | | | |
| Common services of Industrial estate | Normal TOD | 0600-1700 hrs | 525 | 523 | 521 | | | | | |
| | | 1700-2300 hrs | 675 | 672 | 669 | | | | | |
| | | 2300-0600 hrs | 398 | 397 | 396 | | | | | |
| | | 1700-2000 hrs | 511 | 508 | 505 | | | | | |
| | | 2300-0600 hrs | 241 | 240 | 238 | | | | | |
| Short term supply | Normal-TOD | 0600-1700 hrs | 520 | 518 | 516 | | | | | |
| | | 1700-2300 hrs | 557 | 555 | 553 | | | | | |
| | | 2300-0600 hrs | 494 | 492 | 490 | | | | | |
| Private Educational Institutions | | | | | | Normal-TOD | 0600-1700 hrs | 530 | 528 | 526 |
| | | | | | | | 1700-2300 hrs | 568 | 566 | 564 |
| | | | | | | | 2300-0600 hrs | 503 | 502 | 501 |