

1. INTRODUCTION OF TOD TARIFF IN PUNJAB

1.1. Introduction

1.1.1. The Time of Day tariff (ToD) also known as Time of Use (ToU) is a widely accepted Demand side Management (DSM) measure for energy conservation by price. The ToD tariff encourages the distribution licensees to move towards separation of peak and off-peak tariffs which would help in reducing consumption as well as costly power purchase at the peak time. The Tariff is set in such a way that it inherently provides incentives and disincentives for the use of electricity in different time periods.

1.2. Legal and Policy Framework for ToD tariff:

1.2.1. The section 62 (3) of the Electricity Act 2003 says that:

“The Appropriate Commission shall not, while determining the tariff under this Act, show undue reference 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”

1.2.2. The provision no 5.4.9 of the National Electricity Policy also advocates the ToD tariff which says that:

5.4.9 The Act requires all consumers to be metered within two years. The SERCs may obtain from the Distribution Licensees 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.

1.2.3. The provision of the National Tariff Policy (8.4 Definition of tariff components and their applicability) envisages explicitly the emphasis on the ToD Tariff. The provision says that:

“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”

1.3. Status of the ToD implementation in India

1.3.1. At present, SERCs in 14 states have notified ToD tariffs. In the initial stages, ToD tariffs were notified for limited consumer categories, typically for HT industries in most of the states. Some SERCs had even offered flexibility to consumers by allowing ToD tariffs to remain optional during the initial years of introduction. However, with time almost all such states/regulatory commissions have made ToD tariffs mandatory for specific consumer categories. After setting the ToD tariff system for HT consumers several SERCs have also progressively extended it to bring other categories of consumers in the fold of ToD tariffs.

Table 1: Implementation Status of ToD in India

| Sl. | State | Year of implementation | Proposed By (SERC or DISCOM) | Present status (Optional or Compulsory) |
|-----|------------------|---------------------------|--|--|
| 1 | Assam | FY 2003-04 | AERC | Compulsory for HT industry consumers |
| 2 | Bihar | FY 2008-09 | BERC | Compulsory for HT consumers except Railway traction having contracted demand of more than 200 KVA and optional for HT consumers having contracted demand of less than 200 KVA |
| 3 | Chhattisgarh | FY 2005-06 | Applicable since the first order issued by CSERC | Compulsory to EHV and HV consumers of all categories |
| 4 | Maharashtra | Before FY 2000-01 | MERC | Compulsory for HT Industrial consumers, HT commercial consumers and HT sewerage and water treatment plants. Also compulsory for LT Industry (above 20 kW), LT Commercial (above 20 kW) and LT Water treatment and sewerage plants and optional for LT Industry and Commercial (less than 20 kW) connections. |
| 5 | Himachal Pradesh | FY 2001-02 | HPERC | Although ToD tariffs have not been notified in case of Himachal Pradesh but PLEC, which are a form of ToD tariffs have been notified. |
| 6 | Karnataka | FY 2005-06 | KERC | Optional for consumers under LT Industrial (where tri-vector meter is fixed), HT industrial categories and HT water supply. |
| 7 | Gujarat | - | NA | Compulsory for HT consumers with a contract demand of more than 100 kVA and HT water works with a contract demand of more than 50 HP |
| 8 | Uttarakhand | FY 2003-04 | UERC | Compulsory for LT industry with load of more than 25 kW and for HT industry consumers. |
| 9 | West Bengal | FY 2000-01 | NA | Compulsory for HT consumers and optional for several consumer categories in LT category. |
| 10 | Andhra Pradesh | FY 2010-11 | APERC | Compulsory for HT general industry consumers at all voltages. |
| 11 | Orissa | FY 2004-05 | OERC | Compulsory for HT and EHT industrial consumers |
| 12 | Kerala | Before formation of KSERC | NA | Compulsory for HT and Optional for LT industrial consumers |
| 13 | Uttar Pradesh | FY 2003-04 | UPERC | Compulsory for all consumers under large and heavy industry that is with a contact demand of more than 75 kW or 100 HP. |
| 14 | Madhya Pradesh | - | NA | Compulsory for all HT consumers except Railway traction and Bulk residential consumers. |
| 15 | Jharkhand | 2010-11 | JSERC | Compulsory for HT consumers with a contract demand of more than 300 kVA |
| 16 | Delhi | - | DERC | Presently compulsory for all non-domestic consumers with connected load more than 300 KVA. Different Peak and Off Peak hours for April-September and Oct-March April-September: ---Peak: 1500-2400 Hrs ---Off Peak: 0000-0600 Hrs October-March: ---Peak: 1700-2300 Hrs ---Off Peak: 2300-0600 Hrs Surcharge of 10% on peak hours and rebate of 10% on Off-peak hours, during April to |

| Sl. | State | Year of implementation | Proposed By (SERC or DISCOM) | Present status (Optional or Compulsory) |
|-----|-------|------------------------|------------------------------|---|
| | | | | September. Surcharge of 5% on peak hours and rebate of 10% on Off-peak hours, during October to March. |

Table 2: Status of the implementation of ToD in the remaining states

| Name of the State | Status |
|-------------------|--|
| Haryana | No status update. The state is still continuing with PLEC charges which are a form of Time of Day tariff but not pure ToD tariff. |
| Jammu & Kashmir | The ToD tariff was proposed by JKPDD in the ARR for FY 2011-12 but due to non-availability of sufficient data on the consumption pattern of the high value consumers the JKERC has not approved the ToD tariff. The Commission had also directed JKPDD to submit the report on the consumption pattern by 30 th November 2011 so that ToD tariff will be introduced on the FY 2012-13 |
| Punjab | No status update. The state is still continuing with PLEC charges which are a form of Time of Day tariff but not pure ToD tariff. |
| Rajasthan | Though the ToD tariff was proposed by DISCOMS in FY 2011-12, the RERC found that the analysis of the received data resulted in the varying nature of load at peak time. Therefore in view of the requirement of a comprehensive analysis of the load profile the commission directed Rajasthan DISCOMS to rework the load profile and submit the same to Commission. |
| Manipur | No implementation of ToD yet |
| Meghalaya | No implementation of ToD yet |
| Arunachal Pradesh | No implementation of ToD yet |
| Mizoram | No implementation of ToD yet |

1.4. Background of ToD/ToU in other countries

- 1.4.1. All utilities across the world witness the phenomenon of peak, off peak and normal loading conditions. Depending on the geographical conditions prevailing in the country, holidays, weather conditions etc. the total demand witnessed by the utilities varies over the years and even within the same day. Hence high costs of supply during peak hours and relatively lower cost of supply during off-peak and normal hours is a common occurrence in all the utilities. The common approach adopted by utilities across the world over is to notify tariffs that vary with time of usage.
- 1.4.2. In countries where the utilities have deployed smart meters on a substantial customer base, time of use tariffs have gained significant popularity. In several countries across Europe and in many member states of USA, Time of Day (ToD)/Time of Use (ToU) tariffs have been successfully used for flattening out the load curve of a utility and in reducing peak power purchase prices. In the subsequent sections, we shall discuss the implementation of ToD tariffs in different utilities in the world with a focus on the issues encountered, reasons for ToD tariff notification, benefits realized, target consumer base etc.

Europe

- 1.4.3. As part of the energy efficiency measures being promoted by the European Union, the union has given directives to its member states for formulating strategies for saving energy from

end users. In response to demonstrating compliance to this directive several member states in Europe have come up with Time of Use tariffs which are looked upon as an effective measure of modifying the demand of the consumers based on the availability.

- 1.4.4. As part of this initiative utilities in United Kingdom have had time of use tariffs in place for several years now. In the industrial and large commercial sectors, energy intensive users are able to agree on Time of Use and/or interruptible contracts with suppliers and hence are able to reap benefits by consuming during off peak hours.
- 1.4.5. It is estimated that about 4.5 million UK customer make use of multi-rate energy tariffs which involves programmes providing customers with the option to obtain discounted electricity rates at night. ‘Economy 7’ is a program which is an example of these Time of Use programmes: typically from 01:00 to 08:00 in the morning cheaper tariffs are applied so that customers using electrically charged thermal storage heaters can meet their space heating needs from off-peak electricity. In order to participate in these programmes, customers need two-register meters, which most of the time consist of radio and tele-switched meters installed by their distribution network operator or supplier.
- 1.4.6. Italy has also used Time of Use rates for several years. In the past Italy has experienced significant time variations of cost for electricity supply. Part of the potential associated with shifting loads to hours of low price has been put into action by many industries to obtain the most convenient hourly profiles. More recently, Italy has been moving towards peak/off-peak prices to eligible customers. As part of this initiative at policy level, the energy regulator (Autorita` per l’energia elettrica e il gas) has recently introduced a new mechanism for calculating the price of energy with the aim of shifting consumption to periods of lower and cheaper loads. The new pricing system applies to all those end-users in possession of electronic meters; this represents almost 90% of Italian customers. As part of this initiative there are currently two tariffs: a more expensive one from 08:00 in the morning to 19:00 in the evening Monday to Friday and a cheaper one for any other time.
- 1.4.7. Electricite de France, a supplier in France probably operates the most successful example of time of use pricing and has approximately one third of its 30 million consumers on time of use pricing mechanism. This pricing design was first introduced for residential customers in 1965 on a voluntary basis, having been first applied in the country to large industrial customers in 1956. As can be seen from the above stated examples, ToU pricing mechanism has been in place in Europe since several decades and is being successfully used by the utilities to meet their load requirements during peak hours and at the same time to regulate their overall demand.

Australia

Energy Australia

- 1.4.8. Electricity tariffs in Australia are amongst the lowest in the world. However in the recent past the utility – Energy Australia has been witnessing substantial growth in electrical demand particularly during peak hours. In order to avoid infrastructure addition and to bring in efficiency thereby maintaining lower tariffs, Energy Australia introduced smart time of day tariffs called ‘PowerSmart’.

1.4.9. As part of the initiative the utility has identified peak, shoulder peak and off peak hours as under:

| | |
|----------|---|
| Peak | 2pm to 8pm on working weekdays |
| Shoulder | 7am to 2pm and 8pm to 10pm on working weekdays 7am to 10pm on weekends and public holidays |
| Off Peak | All other times |

1.4.10. The tariff during peak periods is defined at the highest level, shoulder peak at intermediate level and off peak at least level. However an important prerequisite for adoption of time of use tariffs in Energy Australia is the installation of smart meters. Energy in these meters is recorded in half hour intervals and stored within the meter. The billing of consumers is then done at the end of the billing period based on the consumption recorded in the various slots.

1.4.11. At present the facility of time of use tariffs is available to small and medium business consumers who use under 40 MWh of energy annually. However as part of its long term plan, Energy Australia plans to progressively implement smart time of use tariffs to increasingly more consumers and consumer groups over the next decade.

Adelaide Solar city

1.4.12. Even in the state of Adelaide in Australia, time of use tariffs have been notified for the benefit of consumers. The utility has gone a step ahead and has notified ‘seasonal’ as well as ‘round the year’ ToD tariffs as under:

Smart time of use – All year

| Usage | Rate (inc. GST) |
|-----------------------------------|-----------------|
| Peak Energy (Mon-Fri, 7am-9pm) | 43.472 (c/kWh) |
| Off Peak Energy (all other times) | 13.640(c/kWh) |
| Supply Charge | 57.387 (c/day) |

Smart time of use – Seasonal

| Usage | Summer (1 Jan to 31 Mar) | Non Summer (1 Aug-31 Dec) |
|-----------------------------------|--------------------------|---------------------------|
| Peak Energy (Mon-Fri, 7am-9pm) | 49.555(c/kWh) | 40.777 (c/kWh) |
| Off Peak Energy (all other times) | 13.640 (c/kWh) | 13.640(c/kWh) |
| Supply Charge | 55.308 (c/day) | 55.308(c/day) |

1.4.13. However even in case of Adelaide Solar city having a smart meter is a pre-condition for availing the benefits of time of use tariffs. Moreover the offer is not available in all areas of the city. It is currently being offered in limited areas. In order to further boost the feasibility of the program, the utility also claims the emission reduction units and energy efficiency credits in respect of the greenhouse gas reduction/abatement.

Time of use tariffs in United States

1.4.14. In the 1970’s and early 1980’s, the Federal Energy Administration sponsored utility trials to determine how to structure TOU rates and whether TOU rates made economic sense for the utility and the customer. Preliminary tests indicated that residential customers would accept

TOU rates with encouraging results. Commercial and industrial customers were typically less responsive, since they have less elastic consumption patterns than residential customers. Even after the early studies, the demand-side management benefits to the utility remained unclear. Regardless of the utility industry's desire to offer residential TOU tariffs, the technology required to record TOU energy consumption was too expensive to consider the introduction of these tariffs. In the remainder of the 1980's many utilities continued to test time-of-use rates, using larger sample sizes and more sophisticated measurement equipment and techniques. These utility studies have shown an average reduction in peak consumption of about 20%, or 0.7 kW per residential customer, and an average reduction in total consumption of about 4.5%, or 450 kWh (EPRI & EEI). In 1989, at a typical value of \$60/kW-year for avoided capacity and \$0.03 per kWh for avoided generation, the benefit to utilities was about \$55 per customer year for time-of-use rates. About 80% of this amount must be returned to time-of-use customers as the benefit of shifting their load, leaving about \$11 per customer year for metering.

- 1.4.15. Applied to all residential customers in the U.S., a 10% reduction in peak would translate to about 20,000 MW (this is about the same as the peak load for all of Pacific Gas & Electric, the nation's largest combined electric and gas utility). A 450 kWh reduction in consumption per customer translates to 40 billion kWh per year. In an effort to participate in this potentially huge TOU market, meter manufacturers made major product advancements. In the 1980s, with the availability of low cost microprocessors, the first reasonably-priced, under-the glass, solid-state TOU register was introduced. Throughout the 1980s, the selling price of TOU registers dropped substantially, bottoming out at about \$125 in large quantities by the end of the decade. Even at this price, TOU programs did not expand as rapidly as the meter manufacturers had hoped. Several utilities have proven that small scale time-of-use programs can be beneficial to both the customer and the utility.
- 1.4.16. Several years Central Maine Power Company introduced a mandatory TOU rate program for those residential customers exceeding 2,000kWh in any winter month, or 5% of their residential customer base. The program has had a significant impact on usage patterns, with customers reducing their overall consumption by 5% to 12% compared to previous years. The net effect has benefited the utility by reducing the residential customer's contribution during winter peak periods by 14%, while customer satisfaction is high. Over the last two decades Pacific Gas & Electric has been a leading proponent of residential TOU rates since their first voluntary residential TOU program was introduced in 1982. Since then, the number of participants has grown to over 86,000 residential customers.

Baltimore Gas and Energy (BGE)

- 1.4.17. BGE has launched the time of use tariffs in June 2011. The same was launched as a component of BGE Smart Energy Savers Program. The program is known as 'PeakRewards'. BGE has notified the time from 7 AM to 11 AM and 5 PM to 9 PM as peak periods, 11 AM to 5 PM as mid cost periods and 9 PM to 7 AM as off peak periods. Accordingly the energy rates have also been determined by the utility. An important difference between the BGE ToD initiative and ToD initiatives in other utilities is that a consumers who opts for ToD tariffs has to stay with these tariffs for at-least one year. The consumers can revert to any other tariff plan only after one year.
- 1.4.18. As is evident from the above examples, ToD tariffs have been in vogue in America since several decades and are being used by utilities as well as consumers to their own advantage.

From the above, it can be safely concluded that the ToD tariff is the tool of the day which is required to be used sensibly to manage the power available with the Utility efficiently.

1.5. Methodology adopted for ToD implementation in Punjab

Current position of PSPCL

- 1.5.1. The basic objective of implementing **Time of Day** tariffs is to flatten the load curve over a period of a day resulting in a reduction in the peaking power requirement and also to enhance power requirement during off peak period. The pattern of load of PSPCL over the year is as per the load curves shown in **Annexure -A**. It shows that the PSPCL has dip in demand during night hours which is quite disturbing during winter period i.e from November to March. Further from the FY: 2013-14 onward the PSPCL shall have added problem of surplus power which as per the estimate of PSPCL has been projected in the ARR of FY: 2013-14 based on the data supplied by CE/PP&R which is as under:

Surplus Energy Available during FY: 2013-14:

| | |
|----------------|---------|
| April, 2013 | 58 MU |
| May, 2013 | 244 MU |
| October, 2013 | 133 MU |
| November, 2013 | 379 MU |
| December, 2013 | 848 MU |
| January, 2013 | 1284 MU |
| February, 2013 | 1015 MU |
| March, 2013 | 1773 MU |
| Total | 5734 MU |

The above surplus power also substantiate the fact that in order to arrest the problem of surplus power in winter and also in view of severe dip in demand in night during the winter months, PSPCL has to take some steps so as to target increase in demand in general and increase in demand during night in particular. Introduction of time of day tariff is answer to the problem as has been implemented in many of the states as per details on proceeding pages.

PSPCL does not have any provision for **Time of Day** tariffs as of now, but in order to mitigate the financial impact of peak power purchase, PSPCL has introduced Peak Load Exemption Charges (PLEC) on all LS consumers except essential services (such as Hospitals, Railway Stations, Railway Installations, Defense & Military Installations, All India Radio/T.V., Water Supply & Sewerage Installations, P&T Installations and News Service Installations etc.) wherein all such notified consumers are required to observe peak load restrictions during evening hours.

- 1.5.2. However, in case of several consumers and industries, continuous operation of specific equipment or machinery is essential for their functioning. Hence, for such or other consumers who wish to avail continuous power even during the evening peak hours Peak Load Exemption Charges (PLEC) have been notified by the PSERC/ PSPCL as under:

- a) Peak Load Exemption Charges for sanction of PLE of 100KW load are. @ Rs.120/- per KW per month minus eligible exemption, i.e. Rs.120/-*(100 - Eligible

exemption). The minimum period for seeking peak load exemption at a time is six months i.e. even if a consumer wants to surrender its exemption prior to six months he has to pay the additional charges for full six months and eligible exemption is the exemption which is eligible to consumers without payment of PLEC during Peak Load Hours Restrictions.

- b) Peak Load Exemption Charges for sanction of PLE above 100KW load are @ Rs.1.80 per KW per hour for the exemption up to 65% of sanctioned contract demand at 90% PF & @ Rs.2.70 per KW per hour for the exemption beyond 65% of sanctioned contract demand at 90% PF.

The above structure of PLEC implementation was issued in 1998 vide PR circular No. 11/98 dated 29/7/98. The tariff for LS consumer at the same time was also revised to Rs 2.85 per unit vide CC No. 26/98 dated 29/7/98 and the revenue for PLEC during the FY: 2012-13 as per format -27 of ARR is estimated to be Rs. 180 crores & the expected revenue for PLEC with current PLEC rate for FY: 2013-14 has been estimated to be Rs.200 crores. The rates as applicable now are also approved by the Hon' able Commission in the year 2010 (applicable from 1.4.2010) with the issuance of the condition of supply.

Peak Load Restrictions are imposed on the LS industry due to inadequacy of the transmission and distribution system to meet the peak hr load. Due to high demand during peak load hrs the cost of power is also high. The PLEC is a commercial mechanism to restrict the load during high demand peak period. The exemption is allowed to the industry during peak load hrs on their specific request after watching the adequacy of the system to stand that much load and availability of power. For use of power during these hrs the industry has to pay the PLEC.

Though the tariff rates has been revised almost every year by the Hon'ble Commission, the peak load exemption charges remained the same since 1998. The rise in tariff is being allowed on year to year basis taking into account the rise in input cost of raw material as well as the fixed charges w.r.t. own generating plants and the Central Sector share allocation and other sources of power input and the rise in wholesale price index etc.

An year-wise comparative chart for the LS category tariff approved by the commission viz-a-viz the applicable peak load exemption charges is given as under:-

| Sr. No. | Year | Industrial Category Tariff (Rs. per unit) | | | Applicable peak load exemption charges (Rs. per unit) | | Remarks |
|---------|------|---|-------------|---------|---|------------------------|--|
| | | MS | LS | General | Up to 65% of SCD | Between 65% to 90% SCD | |
| 1 | 1998 | 2.85 | 2.85 | 2.75 | 1.80 | 2.70 | As per Clause 82.3.1 & 2 of Sales Regulation and PR Circular 11.98 |
| 2 | 2005 | 3.72 | 3.72 | 3.72 | 1.80 | 2.70 | As per CC 42/2005 |
| 3 | 2006 | 3.72 | 3.72 | 3.72 | 1.80 | 2.70 | As approved by |

| | | | | | | | |
|---|------|------|-------------|------|------|------|-------------------------|
| | | | | | | | PSERC |
| 4 | 2007 | 3.98 | 3.98 | 3.98 | 1.80 | 2.70 | As per CC 52/2007 |
| 5 | 2008 | 3.95 | 3.95 | 3.95 | 1.80 | 2.70 | As per CC 63/2008 |
| 6 | 2009 | 4.33 | 4.33 | 4.33 | 1.80 | 2.70 | As per CC 29/2009 |
| 7 | 2010 | 4.58 | 4.58 | 4.58 | 1.80 | 2.70 | As per CC 22/2010 |
| 8 | 2011 | 4.95 | 4.95 | 4.95 | 1.80 | 2.70 | As approved by PSERC |
| 9 | 2012 | 5.61 | 5.61 | 5.61 | 1.80 | 2.70 | As per CC 20/2012 |

From the position explained above, it is evident that though the year to year rise in tariff for the industrial category of consumers has been allowed by the Hon'ble Commission yet the peak load exemption charges have remained the same since 1998. Now as the cost of power has increased consistently, the existing peak load charges also need to be revised proportionally. It is proposed that as the present tariff has doubled since 1998, the peak load exemption charges may also be raised accordingly & separate Petition to allow increase in PLEC charges has been submitted with the prayer that:

"The revision of peak load exemption charges as twice of the present charges."

The following paragraphs elaborate the steps taken for implementation of ToD tariffs in the state.

1.6. Assessment of demand of LS consumers as a whole

- 1.6.1. Once the consolidated demand of the identified feeders was available, the next task was to extrapolate the same to the entire base of LS industrial consumers. As the identified feeders were all either independent industrial feeders or predominantly industrial feeders, hence, it can be safely assumed that the nature of the demand curve of all the LS industrial consumers put together would be similar to the nature of the demand curve of the identified feeders. Accordingly, a few assumptions were made for construction of demand curve of LS consumers as a whole. The following assumptions were made for the same:

*Average load of LS consumers = Total connected load * Average Utilization factor*

Average utilization factor

$$= \frac{\text{Total consumption of LS consumers during the year (in kWh)}}{\text{Total Sanctioned Demand (in kVA) * 8760 * 0.9}}$$

Load contribution of LS consumers at any instant

$$= \frac{\text{Consolidated load of feeders at the instant} \times \text{Average load of LS consumers}}{\text{Average load of feeders}}$$

- 1.6.2. Using the above three equations the load of LS Industrial consumers put together was estimated for each of the time blocks independently and the demand curve based on average daily demand for LS category was generated.

- 1.6.3. As can be seen from the graphs depicting the loading pattern of feeders and comparing the

same with the overall loading pattern of PSPCL, it becomes clear that there is significant overlapping of loading of industrial consumers with the overall loading pattern of PSPCL. Although towards the evening hours, there is a dip in the demand of industrial feeders, probably due to observation of peak load curtailment, but over the rest of the day industrial consumers have a stable demand. Hence there is substantial potential for consumers as well as PSPCL to benefit through introduction of ToD tariffs as any increase in demand during off peak period will tend to flatten the curve of overall demand of PSPCL.

Cost benefit analysis of ToD implementation

1.6.4. After going through the above mentioned steps, the cost benefit analysis of implementation of ToD tariffs was done. The key assumptions made for undertaking the cost benefit analysis are as under:

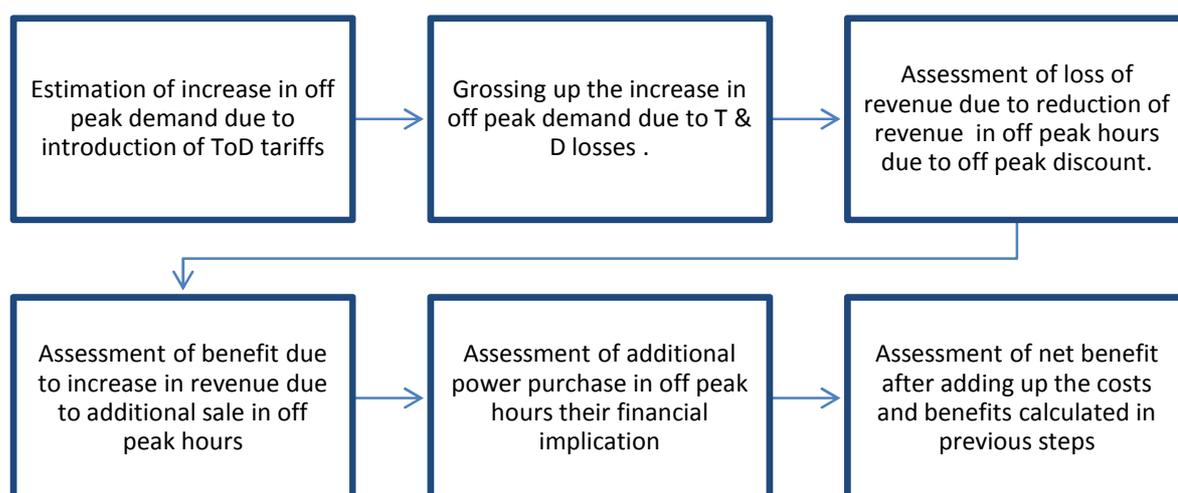
- a) **Specific parameters for LS consumers:** In case of LS consumers, the load graph for all the consumers was constructed after extrapolating the loading pattern of the selected feeders to the entire LS consumer base. For the extrapolation, the power factor and the average utilization factor of LS consumers was considered as explained in the equations above. For the purpose of the current study the power factor and the average utilization factor for LS consumers has been considered at the average value so that the average load curve matches with the billing data of PSPCL.
- b) **Reduction in load by LS consumers:** The actual reduction of loading during the peak periods and normal period post introduction of the ToD tariffs would depend on the industry's ability to shift processes/ manufacturing cycles. **Therefore, a base case scenario of no reduction of load by industrial consumers for the entire period of normal tariff and no reduction in load in peak tariff period has been assumed for the current study.** It has been assumed that during peak period the consumers have got their minimum requirement sanctioned and the industrial consumer operating during normal period may not like to shift their working pattern immediately. However the same may vary in actual practice and PSPCL may have to modify its ToD tariff structure in future based on actual experience.
- c) **Increase in consumption during off peak hours:** It has been assumed that LS consumers would not reduce their consumption in view of notification of ToD Tariffs but shall try to increase their usage in the off peak period to take benefit of the off peak lower tariff rates to reduce their average cost of conversion/production. Although there may be some shift of consumption from the normal period to off-peak period, but for the sake of simplicity it has been assumed that the reduction in demand during normal period shall be compensated with the addition of new consumers/load/demand as the system constraints shall ease out giving way to new consumers/load/demand. Accordingly, it has been assumed that the reduction in consumption witnessed in normal tariff periods would be compensated. The entire rise in demand has been assumed to be equally distributed in the off peak hours. It is further assumed that with the introduction off peak period tariff there will be increase of 10%-15% of average load during off peak period tariff.
- d) **Time period of peak and off-peak hours:** For the purpose of this study it has been assumed that over a day, the total duration notified as peak period and the total

duration notified as off peak period is not the same. Peak hours have been identified as 18:00 hours to 22:00 hours every day whereas off-peak hours have been identified as 22:00 hours to 06:00 hours every day for the months of October, November, December, January, February and March only. This has been done because it was noticed during initial analysis that in the rest of the year no distinct peaks/off peaks were observed during the 24 hours of a day. Hence it has been proposed that ToD tariffs be notified only for this period.

- e) **Cost of power purchase:** In off peak periods, due to any reduction in demand, the principle of merit order dispatch warrants that the costliest power should be surrendered by PSPCL first and foremost. In case the scheduled costliest power is less than the total load relief required, the next costliest power should be surrendered and so on. However, considering that the supply from most of the sources of PSPCL is governed by long term power purchase agreements hence it cannot be assumed that the costly power from such long term sources would not be purchased. Hence it has been assumed that PSPCL would continue to purchase power from these sources but would sell it at the average rates witnessed in the Indian Energy Exchange (IEX) for the respective months namely January 2012, February 2012, March 2012, October 2012, November 2012 and December 2012 respectively attached as **Annexure B**. On the other hand, introduction of ToD tariffs would increase the power purchase requirements during off peak hours and it cannot be predicted that the power so purchased, would be at what rate. But it can be safely presumed that the average rate of power purchase in this period will be lesser than average rate of power purchased in peak and normal hours. Accordingly it has been assumed that the power purchased during off-peak hours shall be at the average power purchase rate of PSPCL for the full year that is 2011-12 (as has been proposed by PSPCL in its ARR & tariff petition) attached as **Annexure C**.
- f) **Costs and benefits involved:** For the current study since the metering and billing infrastructure of PSPCL is enough to meet the requirements of ToD implementation, it has been assumed that no costs or marginal costs on this account shall be incurred. The only requirement of PSPCL will be to ensure the reading of all 7000 (approx) LS consumers through Meter Reading Instruments (MRI's) to obtain/download the data of all the registers which can be easily achieved by providing MRI's at the level of Sr. Xen in the field and PSPCL is already considering the same and shall be ready with the same before OCT 2013 i.e by the date when the TOD tariff will take effect. However there are expected to be other costs as well as benefits accruing due to ToD implementation. The costs and benefits envisaged in the current study are listed as under:
- Cost of additional power to be purchased during off peak hours due to increase in load during off peak periods and selling the same and already recorded demand at discounted rate.
 - Benefits accrued due to additional sale during off peak hours and due to lesser average cost of power purchased.
 - Benefits accrued due to flattening of demand curve which shall allow new consumers/load/demand which shall increase the existing low utilization factor

of LS industrial consumers which is at present approx 20% only on sanctioned load basis.

- 1.6.5. Based on the above assumptions, the cost benefit analysis was undertaken. Another assumption that was made was that the transmission and distribution losses to be incurred by PSPCL would remain at 17% as has been proposed by PSPCL in their ARR and Tariff petition for FY 2012-13. The detailed methodology that has been adopted is summarized in the figure below:



- 1.7. Based on the methodology adopted above, the costs and benefits have been estimated for the study. During the cost-benefit estimation it was evident that the benefits that could be gained through implementation of ToD tariffs depend on three key parameters, as below:

- a) **Number of slots identified for ToD implementation:** Since the starting point of ToD implementation is identification of peak and off-peak hours hence as the band of off peak hours are expanded, the expected benefits to consumers also increase. At the same time, if the peak and off-peak hours are constricted, the benefits also reduce. Furthermore, based on the experience of PSPCL, it was felt that the LS consumers, who are willing to pay PLEC charges even now, would not be willing to shift their demand unless substantial benefits are offered to them. Also the benefits should be offered for a reasonably long duration so that they may accommodate their entire shift in the same. Hence it was decided that off-peak hours should be offered for the entire period from 22:00 Hours to 06:00 hours. Also peak hours should be restricted to 18:00 hours to 22:00 hours. The penalty during peak hours should be stiff and also the benefit during off peak hours should be reasonably high.
- b) **Percentage shift in demand envisaged through ToD adoption:** Another important parameter that affects the financial benefits of ToD adoption is the total expected shift in demand of the target consumer category. Since at this point, it cannot be ascertained how much demand would shift, hence for the purpose of this study, it has been assumed that a total of 10%-15% of the total LS demand in off peak hours would increase seeing the benefit of off peak tariff rates. It has been assumed that PSPCL would be able to sell all its peak power and power in normal hours. Hence as per this basic assumption, as the total shift in demand increases, PSPCL would be able to sell more of its power at the rates higher than

the average rates witnessed in the energy exchange, which means that PSPCL would be able to sell even its cheaper power at higher rates. The benefit of PSPCL increases with the increase of power load in off peak period.

There are additional benefits of flattening of demand curves such as i.e. reduction in system peak demand, reduction in the need for the upstream network (transmission & sub-transmission) capacity etc. which has not been considered in the present analysis but would benefit the PSPCL in achieving reduced overall cost of supply for the consumers.

- c) **Extent of benefit provided to consumers for adoption of ToD tariffs:** As stated earlier, the LS consumers of PSPCL shall straightway get benefit of lower tariff during off peak hours to the extent of their usage in the off peak hours. The benefit passed on to the consumer shall affect the utilization factor of LS consumers which is very low at present being only 20% w.r.t. the Sanctioned Load and is expected to increase which shall benefit the state also.
- d) **Balance of cost and benefit:** Balance between the benefits that can be passed on to consumers in ToD regime needs to be maintained with the cost of such benefits to PSPCL. In the current study, several scenarios have been assumed wherein the total cost and benefit accrued to PSPCL has been assessed by varying the increase in demand in the off peak period and the benefit in tariff which can be offered during the off peak period. It is to be kept in mind that a balanced figure needs to be worked out for ToD implementation so as to ensure that the consumers are reasonably interested in ToD adoption and at the same time the demand curve of PSPCL moves towards flattening but PSPCL is not put to loss to a significant extent. The broad objective being is to make a win-win proposition for consumers and the PSPCL through introduction of ToD tariffs.

- 1.8. Based on the above observations the cost benefit analysis has been undertaken for the current study. The findings of the same are presented with the help of dynamic model and the result as the model illustrates as under :-

| | | Increase in non-peak period demand | | | | | | |
|------------------------------|------|------------------------------------|---------|---------|---------|--------|--------|--------|
| | | 0% | 10% | 20% | 25% | 30% | 35% | 40% |
| Off-Peak Discount in Paisas. | 0.00 | 0.00 | 34.38 | 68.77 | 85.96 | 103.15 | 120.34 | 137.53 |
| | 0.50 | -64.83 | -36.93 | -9.03 | 4.92 | 18.87 | 33.82 | 46.77 |
| | 0.60 | -77.80 | -51.20 | -24.59 | -11.29 | 2.01 | 15.31 | 28.61 |
| | 0.70 | -90.77 | -65.46 | -40.15 | -27.50 | -14.84 | -2.19 | 10.46 |
| | 0.80 | -103.76 | -79.72 | -55.71 | -43.71 | -31.70 | -19.70 | -7.69 |
| | 0.90 | -116.70 | -93.98 | -71.27 | -59.91 | -48.56 | -37.20 | -25.84 |
| | 1.00 | -129.66 | -108.25 | -86.83 | -76.12 | -65.41 | -54.71 | -44.00 |
| | 1.10 | -142.63 | -122.51 | -102.39 | -92.33 | -82.27 | -72.21 | -62.15 |
| | 1.20 | -155.60 | -136.77 | -117.95 | -108.15 | -99.13 | -89.72 | -80.30 |

All figures indicating are is in Crores (+ve indicates profit / -ve indicates losses)

- 1.9. As can be seen from above analysis that the situation would be most beneficial for all when the tariff during off peak hours is reduced by 15% (sayRs.1 per unit) which is considered as the discount which need to be offered to attract the existing consumers to increase their off peak consumption to have reduction in their conversion/production cost . It has been estimated that there will be 10% increase in demand during off peak period with introduction of ToD tariff.

From the table given in Para 1.8 above, it can be seen that with the rebate of 15% (Say Rs. 1 per unit), the loss to the PSPCL is to the tune of Rs. 129 crores (calculations attached as **Annexure-D**) with no change in the demand pattern. This loss is reduced to Rs. 108 crore in case the demand during off peak period increases by 10% as estimated (Detail calculation attached in **Annexure-E**) & the expected demand curves for overall of PSPCL & for the LS industry are as shown in **Annexure-F**. These curves shows the flattening of demand curves with off peak increase Accordingly, more & more increase in off peak consumption will benefit PSPCL more & more. Further, TOD tariff can be adjusted in subsequent years with the inputs of data regarding demand movement on the introduction of TOD in Punjab to maximize the benefits of ToD tariff.

1.10

The above expected loss to PSPCL is proposed to be adjusted/recovered from the additional revenue proposed to be generated from increase in PLEC charges for which the petition has been submitted and is already under consideration of PSERC.

Recommendations for ToD implementation

Based on the analysis undertaken above, the following points are kept in mind by PSPCL while proposing ToD tariffs:

- a) **Target Consumer category:** At this juncture, considering the availability of metering infrastructure amongst the LS Industrial consumers which is a pre-requisite for ToD implementation, PSPCL initially propose ToD rates for these consumers. Although HT consumers from other categories have also been provided with such tri-vector meters but the same should not be taken into the ambit of ToD tariffs at this point because the nature of their load variation is not conducive to ToD tariff. However in subsequent phases the MS consumers can also be covered to fall under ToD tariff regime after data relating to their consumption pattern is suitably analyzed and the required meters are installed on all consumers which is a pre-requisite for implementation of ToD tariff. For the MS consumers where the meters are already installed cannot be included in the first phase as such meters will also be required to be read with MRI so as to make available the data of all registers for billing on ToD tariff. Accordingly, it is proposed that all other HT consumers and MS consumers other than LS industrial consumers shall be covered under ToD tariff from the next financial year i.e. 2014-15.
- b) **Target peak and off peak hours:** Looking at the graphs discussed earlier and also the cost benefit analysis undertaken, PSPCL should propose 8 slots of 30 minute duration as peak hours and 12 slot as off peak hours. Also this should be defined only for six months of the year only (October to March) as in the remaining six months a definitive trend of peak and off peak is not observed. Considering the uncertainty that the initiative would receive from consumers, at this point it is advisable to notify smaller ToD periods as provided in the table under:

| Period | Tariff |
|--------------|---------------------|
| Normal hours | 06:00 to 18:00 Hrs. |
| Peak period | 18:00 to 22:00 Hrs. |
| Off peak | 22:00 to 06:00 Hrs. |

- c) **Incentive and rebate to be given in ToD:** As a starting step, it is proposed that an incentive of 15% (say Rs.1 per unit) be offered to consumers during off peak hours for six months of the year only (October to March). Since the TOD model is based on certain assumptions of load shifting and the end results shall be dependent on the preference of industry and the ToD tariff shall require adjustments every year.