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For more information

Project Monitoring Cell
T E R I
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi – 110 003
India

Tel. 2468 2100 or 2468 2111
E-mail pmc@teri.res.in
Fax 2468 2144 or 2468 2145
Web www.teriin.org
India +91 • Delhi (0) 11

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Time-Of-Day Tariffs for Residential Consumers in Delhi

Introduction and objective

In February 2007, The Energy and Resources Institute (TERI), along with the GoNCTD (Government of National Capital Territory of Delhi) initiated a programme called DEEP (Delhi Energy Efficiency Programme) with an objective to make Delhi an energy efficient city. An important part of this effort is to structure tariffs in a manner that would provide an incentive to shift consumption from peak to off-peak periods, and to encourage use of more efficient appliances. The aim is to design and demonstrate the impact of ToD (time-of-day) pricing and use of energy efficient appliances on consumer and the utilities. For this purpose three areas have been selected for pilot demonstrations for implementation in select areas of the city.

The above task is being jointly undertaken along with the EE&REM (Energy Efficiency and Renewable Energy Management) Centre of Delhi Transco Ltd, a GoNCTD undertaking. Some of the phases of the programme include area identification, selection of DSM (Demand Side Management) measures based on cost-benefit analysis, sample survey to establish baseline parameters, preparation of implementation plan and monitoring and evaluation. These tasks are being accompanied by extensive awareness campaigns, education outreach programmes etc. The learning from this programme would provide successful cases to be replicated in other parts of the Delhi and elsewhere.

The areas selected for pilot study are IP Extension (BYPL area of supply), Vikas Puri Blocks H, H1, H2 and H3 (BRPL area of supply) and Rohini Sector 9 (NDPL area of supply).

Rationale for time-of-day tariffs for residential consumers in Delhi

Supply side

One of the problems facing the electricity sector in Delhi has been its growing demand-supply imbalance. Delhi's power demand has been growing rapidly. In the last decade (1995-96 to 2005-06), the city's demand grew at an average growth rate of around 6% annually[1]. Delhi has already recorded a peak demand of 3900 MW during the summer month of July 2006, which is expected to rise even further.

1 Calculated using the annual peak demand figures published in CEA General Review

Power requirement in Delhi is met by generation capacity within Delhi, allocations from Central Generating Stations (CGS), and other banking and bilateral arrangements. As per the Delhi Electricity Regulatory Commission's (DERC) order dated 31 March 2007 on reallocation of Power Purchase Agreements (PPAs), the total firm capacity allocated to Delhi including CGS allocations has been 3132 MW[2]. The city's power plants, due to problems of old age and low gas supply, generate way below their capacity, at a plant load factor of 43.6% (Ministry of Finance. 2004). The net cost of generating power from Delhi's own power plants is generally high due to their low capacity utilization and high fuel consumption.

Overtime, there has been a consistent gap between energy requirement and availability, and between peak demand and peak met in the city. In addition to being dependent heavily on the Northern Grid to meet the demand, Delhi has some peculiar seasonal demand characteristics due to which the requirement keeps changing. As a result, it becomes difficult to plan annual requirement in a supply deficit scenario. The peak seasons in Delhi coincide with that of other neighbouring states, thereby creating a peak deficit in the grid. Apart from the shortages, there are a number of stability issues that the electricity-starved northern grid faces due to overdrawl by number of states. In June/July 2006, the grid was on the verge of collapse with frequency of supply constantly hovering below the permissible value. This results in poor and unreliable power supply, including frequent power cuts due to shortages and considerable fluctuation in voltage and frequency.

Thus, it is felt that proper pricing of electricity can help in improving the situation by prompting the consumers to use electricity more efficiently. Implementation of time-of-day tariffs is also valid in view of the principle of cost causation i.e. the category that is responsible for causing peak shall pay for it and intervention in this category shall result in maximum impact.

Demand side

In Delhi, residential consumers dominate the electricity consumption profile not only in terms of numbers but also in terms of load and consumption. Figure1, 2 and 3 indicate the percentage composition of residential consumers by number, load and consumption.

2 In addition to the above, there is a 15% unallocated share in (BTPS, Dadri, IP, RPH, PPCL, GT) amounting to 299 MW, which is allocated to BYPL.

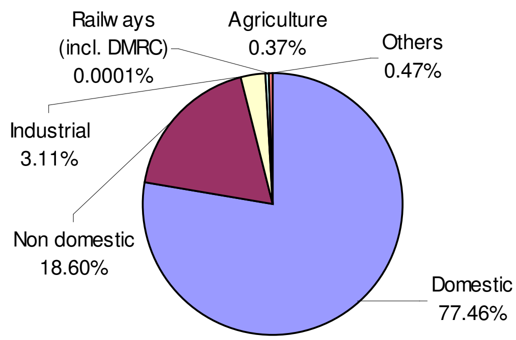

Figure 1: Category-wise percentage composition of number of consumer for FY 2005-06 (Others include public/street lighting and temporary sales)

Source: Data obtained from Delhi Electricity Regulatory Commission (DERC)

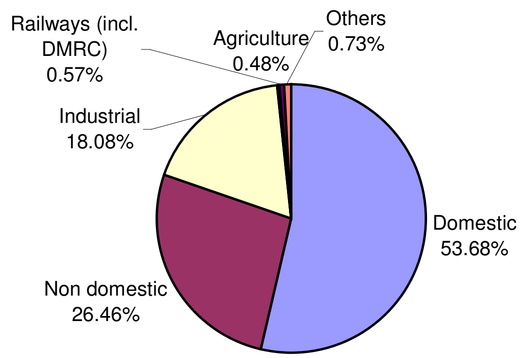

Figure 2: Category-wise percentage composition of sanctioned load for FY 2005-06

Source: Data obtained from Delhi Electricity Regulatory Commission

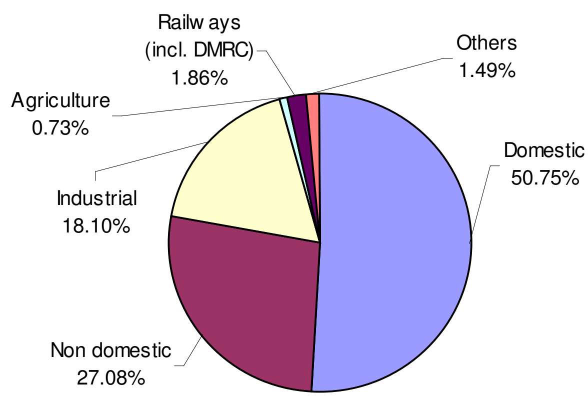

Figure 3: Category-wise percentage composition of consumption for FY 2005-06

Source: DERC Order for FY 2005-06 (Approved sales)

Owing to their dominance in the overall consumer profile, residential consumers also contribute to a high incidence of peak load. In a study undertaken by TERI in 2006, a survey was undertaken in 1000 households of Delhi to understand the ownership and usage pattern of various electrical appliances[3]. The findings of the study were also used to estimate peak load on account of residential consumers. During summers, peak load in the mornings and evenings was estimated at 1850 MW and 2415 MW. Similarly, during winters, it was estimated as 2476 MW and 1861 MW respectively. Figures 4 highlight the peak load during summers and winters.

Summer

In summers, the evening peak is higher than the morning peak with ACs (Air Conditioners) as major contributor to the load. Furthermore, lighting load during evenings is generally higher than in the mornings. Other appliances used include washing machines, refrigerators, televisions, water pumps, and electric irons. These are used intermittently during the day (except refrigerators).

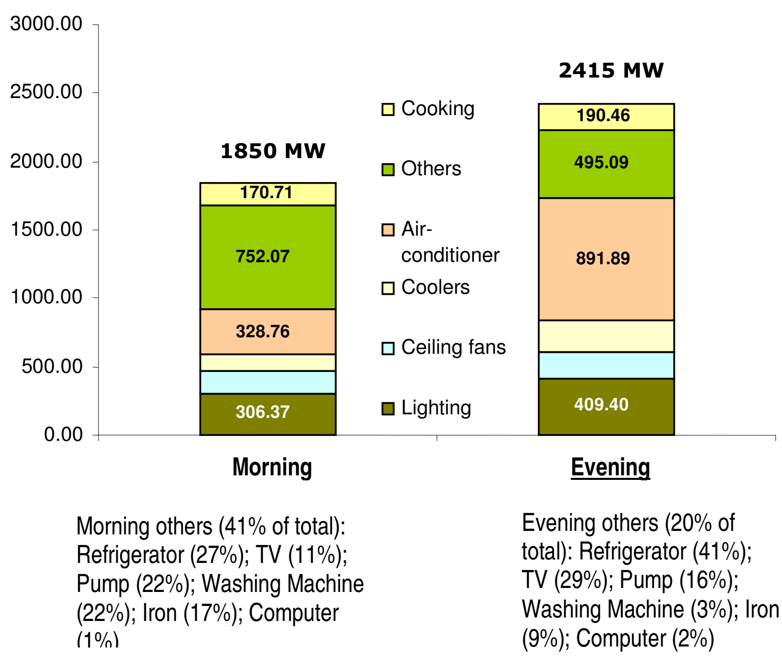

Figure 4 Morning and evening peaks during a peak summer month in Delhi
Source Estimated from survey (Delhi) results; Morning: 6.00 am to 10.00 am and Evening: 6.00 pm to 10.00 pm

3 Detailed publication titled, "Managing power demand: a case study of residential sector in Delhi", highlighting the survey (Delhi) findings and methodology of estimating the peak load is attached with this report for further reference.

Winter

Morning peak in winters is higher than evening peak and is nearly equal to the evening peak during summers. As expected, water heating is the major contributor to this peak load. Figure 5 shows the end use-wise break up of the estimated peak load for the residential sector. Cooking and water heating, as mentioned earlier, have an insignificant contribution. Other appliances used include washing machines, refrigerators, televisions, water pumps, and electric irons.

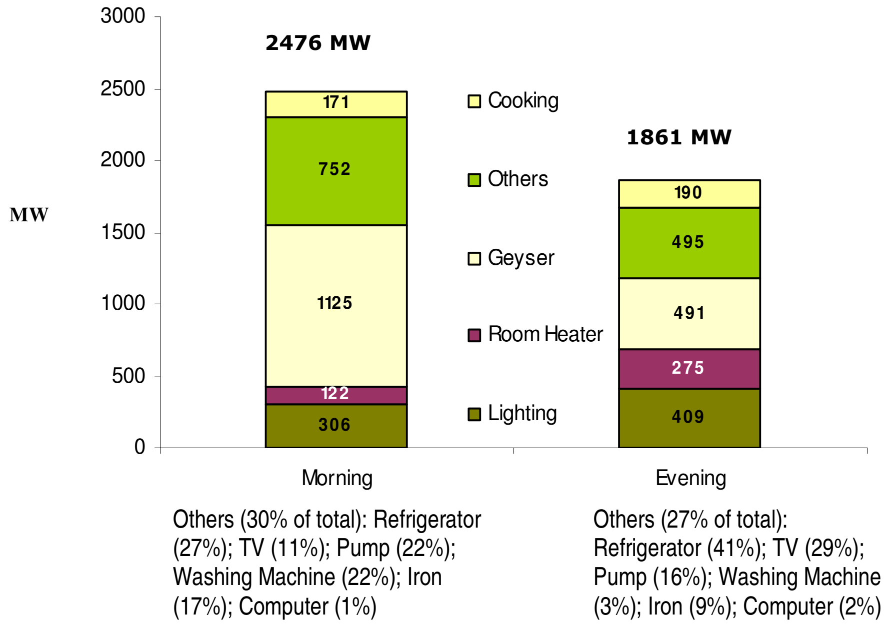

Figure 5 Morning and evening peaks during a peak winter month in Delhi
Source Estimated from survey (Delhi) results; Morning: 6.00 am to 10.00 am and Evening: 6.00 pm to 10.00 pm

In view of the above, it would be worthwhile to examine the introduction of time-of-day tariffs for residential consumers and its impact of the overall load profile of the city. This study aims at the above, by undertaking pilot studies in three selected areas. However, before we discuss the design of ToD tariff, it is important to understand the load profile of Delhi. The following section provides a detailed analysis of the same.

Status of Metering in Delhi

Implementation of time-of-day requires adequate metering infrastructure to be in place as it requires recording the demand and energy consumed in different time slots. Under ToD tariff regime, single-phase (1 Ø) electronic ToD energy meters should have facility for date storage, provision for setting tariff slabs, a clock and battery and a communication port. In addition, it would require an interfacing device (MRI) for downloading the data, and change in billing software for billing the consumer for different time periods of consumption.

Based on the interaction of TERI and EE&REM officials with distribution companies in Delhi, the following points emerged that highlight the status of present metering system in Delhi.

BSES Area of supply

- All meters replaced since 2005 are ToD compliant. In IP Extension and Vikas Puri, the areas selected for pilot study, majority of meters are ToD compliant. These meters can take up to 5 time interval slots
- During the meeting it was also highlighted that ToD tariffs cannot be telescopic in nature as it is difficult to program the meter to record the energy in that manner for different time slots.

NDPL Area of supply

- There are limited numbers of ToD compliant meters as of now. In Rohini Sector 9, area selected for pilot, meters are not ToD compliant.

Both the discoms have expressed their willingness to move ahead with the scheme. While BSES already has ToD compliant meters, NDPL has assured that they would be in a position to replace the meters of consumers who opt for ToD tariffs. Associated changes in billing software will also be done.

Load profile of Delhi and Northern Region (NR)

In order to appropriately design time of day tariffs (ToD), it is important to understand the load profile of the city and to ascertain the occurrence of peaks during the day and across different seasons. Alongside, it is equally important to compare these peaks with peak occurrences in the NR. This is because Delhi draws power from the Northern Grid at times when there is shortfall in its firm allocation (MW capacity) and there is unmet demand in the system. Thus, if Delhi is facing peak demand at a particular time and there is power available in the grid, it would not truly qualify as peak period as it can easily draw from the northern grid. However, if both Delhi and the NR face peak simultaneously, then it would certainly qualify as true peak period. The aim towards analysing the load curves is two-fold. Firstly, to ascertain the time of peak occurrence so as to design interventions that result in shift of peak to off-peak periods and hence flatten the load curve. Secondly, to understand the load behaviour of Delhi consumers so as to design energy efficiency and demand side management interventions that will bring the overall demand and hence the load curve down.

Analysis of load curves in Delhi

The load curves analysis is based on data collected from Delhi Transco Ltd (DTL) and Northern Region Load Dispatch Centre (NRLDC). The data pertains to two days for each month – one typical day and the other with the highest peak demand in the month. The load curves are attached as annexure 1 and 2 for further reference.

FY 2006-07

Summers

April 06 (28th and 29th day)

- Peak met was 3361 MW at 7.00 pm in the evening. The unrestricted demand during this period (approximately at 8.00 pm) reached 3428 MW.
- There were three minor peaks at 12.00 pm, 2.00 pm and 4.30 pm where the unrestricted demand was 3200 MW approx. (restricted demand was close to 3000 MW)
- Demand (both restricted and unrestricted) was less than 2800 MW during the late night hours until morning (from 1.00 am to 10.30 am in the morning)

May 06 (26th and 31st day)

- Peak met was 3843 MW at 8.30 pm in the evening. The unrestricted demand during this period was of the same order.
- There were three minor peaks at 12.30 pm, 2.30 pm and 4.30 pm where the unrestricted demand was above 3450 MW approx. (restricted demand was also above 3300 MW)
- Demand (both restricted and unrestricted) was around 2950 MW during the late night hours until morning (from 2.00 am to 10.30 am in the morning)

June 06 (23rd day)

- Peak met was 3645 MW at 10.00 pm in the evening. The unrestricted demand during this period was of the same order.

- There was one minor peak and three major peaks at 9.30 am and 4.30 pm, 7.30 pm and 10.00 pm where the unrestricted demand was around 3650 MW approx.
- Demand (both restricted and unrestricted) was around 2900 MW during the late night hours until morning (from 2.00 am to 8.30 am in the morning)
- Considerable load shedding occurred during this month. The highest being 484 W at 4.00 pm on 23rd day.

July 06 (7th and 14th day)

- Unrestricted peak (peak 1) occurred on 7th at 3.30 pm and was of the order of 3983 MW.
- Unrestricted demand was also high ~3900 MW between 8.30 pm (peak 2) to 10.30 pm (peak 3).
- 7th day witnessed extensive load shedding, which went to as high as 961 MW. Load shedding occurred throughout the day.
- Demand (unrestricted) was between 3100-3300 MW during the late night hours until morning (from 1.00 am to 9.00 am in the morning).

August 06 (18th and 28th day)

- ***18th day*** – Unrestricted peak was 3888 MW at 8.00 pm. Demand remained above 3500 MW from 10.30 am to 11.00 pm at night. It exceeded 3700 MW during 6.30 pm to 11. 00 pm. Unrestricted demand was around 3100 MW during the late night hours until morning (from 2.00 am to 8.00 am in the morning)
- ***28th day*** - Unrestricted peak was 3687 MW at 7.30 pm in the evening. It remained above 3500 MW from 7.00 pm to 10.00 pm. Unrestricted demand was less than 3300 MW throughout the remaining day. Unrestricted demand was around 2950 MW during the late night hours until morning (from 3.00 am to 8.30 am in the morning)

September 06 (13th day)

- Peak met was 3661 MW at 7.30 pm in the evening. The unrestricted demand was also of the same order. The demand remained close to 3500 MW till 10.00 pm.
- The demand touched 3400 MW at 2.30 pm (minor peak).
- Demand (both restricted and unrestricted) was less than 2900 MW during the late night hours until morning (from 2.00 am to 09.30 am in the morning)

Winters

October 06 (5th and 12th day)

- Maximum unrestricted peak was 3701 MW at 7.30 pm on 12th day. There was load shedding of the order of 150 MW approximately during this period. Peak occurred at the same

time i.e. 7.30 pm where 3592 MW was met on 5th day of this month.
- Demand (both restricted and unrestricted) was less than 2700 MW during late night and early morning hours (from 2.00 am to 9 am. It rose to ~ 3100 MW at 3.30 pm during the day.

November 06 (15th and 17th day)
- This month is clearly categorized by two peaks although the overall peak demand remained less than 3000 MW.
- Peak occurred at 6.30 am and 6.30 pm approximately.
- The remaining day had demand less than 2400 MW.

December 06 (15th and 20th day)
- Similar to November, this month is also demarcated by two peaks during the day. Morning peak is higher than evening peak. Peak demand was of the order of 3100 MW.
- Morning peak was around 3100 MW at 7.30 am. Evening peak was slightly less than 3000 MW occurring at 5.30 pm.

January 07 (12th day)
- This month also demonstrates occurrence of two peaks, morning and evening, with morning peak being higher than the evening peak.
- Peak met in morning was 3289 MW, which occurred at 10.00 am. In the evening the peak demand (approx. 3100 MW) occurred at 7.30 pm.
- Late night and early morning hours (1.00 am to 7.00 am), the demand was less than 2500 MW.

February 07 (14th day)
- Similar to January, this month also demonstrates occurrence of two peaks, morning and evening, with morning peak being higher than the evening peak.
- Peak met was 3018 MW, which occurred at 7.30 am. The demand was less than 3000 MW for the remaining day.
- Evening peak had a magnitude of approx. 2800 MW and occurred at 7.30 pm.

March 07 (31st day)
- In March, evening peak became dominant. The magnitude was 3107 MW and occurred at 7.30 pm.
- Demand was less than 2500 MW in late night hours until 10.00 am (1.00 am to 10.00 am). From 10.00 am to 5.30 am it reached a maximum of 2600 MW approx.

From the above analysis the following findings emerge:
- Peak demand in summer months was higher than in winter months. It touched its maximum during peak summer

months. Months of June, July and August witnessed extensive load shedding.

- Peak demand from November to March is usually less than the remaining months. Demand in these months was less than 3300 MW throughout.
- Evening time (from 6.30 pm to 10.30 pm) is peak in most of the months.
- Day timings (9.30 am to 6.30 pm), particularly in summers also highlight occurrences of minor peaks; hence this time is not essentially off-peak in nature. But the magnitude of peak is less than the evening peak.
- Winters demonstrate a more structured pattern of demand than summers, clearly demarcating occurrence of peak during morning and evening. Morning peaks in winter is usually higher than evening peaks. This is true particularly for December, January and February, when geyser load in the morning becomes dominant. In winters, morning peak occurrence is primarily in the time slot 6.00 am to 9.00 am.
- Morning hours (6.00 am to 9.00 am) in the remaining months (other than of December, January and February) also are not truly off-peak hours, as demand remains high during some months.
- While the timing of 6.00 am to 9.00 am can be characterized as normal owning based on the load curve, however during the meeting with utilities it was highlighted that it change in time slot during different seasons may lead to billing problems when meter reading is slightly delayed. This is because same time slot during 3 months of winters (December, January and February) will become peak time and will be normal in remaining months. Thus, to avoid any irregularities in the metering and billing, the time slot of 6.00 am to 9.00 has been characterized as peak, throughout the year. The tariffs have been designed keep this in mind.

Analysis of load curves in Northern Region

Analysis of load curves in the NR indicates the following: -

- In most of the months, peak of Delhi in the evening overlaps with that of the NR. This clearly conveys that reducing peak demand of Delhi at these times will also help in maintaining better grid frequency as there is shortage in the grid during these hours.
- In December, January and February too, the morning peak overlaps with that of the NR.

Time slots for tariff design

Based on the observations highlighted above and metering constraints and requirements, the following time slots are arrived at for both summers and winters: -

Table 1 Time slots for ToD tariffs

Timing	Remarks
06.00 am to 09.00 am	Peak
09.00 am to 06.30 pm	Normal
06.30 pm to 10.30 pm	Peak
10.30 pm to 06.00 am	Off-peak

Proposed tariff structure and design

The proposed tariffs have been designed such that the utility remains revenue neutral (i.e. the decrease in revenue from lower tariffs during off-peak and normal hours is offset by higher revenue at the peak hours) and the consumer expenditure neutral (i.e. in case of no change in appliance and consumption pattern they incur the same electricity bill). Any change in revenue due shift/change in consumption and associated change in the power purchase cost has been separately accounted for.

The impact of replacement of inefficient appliances and change in usage pattern on the consumers and utility has been estimated in subsequent sections. Given below is the procedure/framework adopted to estimate the ToD rates.

Slab-wise sales, Revenue & Avg. Tariff (energy charge) of distribution licensees[4]

The actual slab-wise sales, revenue from energy charges and average energy charges for the three distribution licensees was obtained from tariff petitions filed by them for FY 2005-06 (Table 2 and 3). It is important to specify here that the revenue indicated in Table 3 indicate revenue accrued on account of energy charges only. Revenue from variable charges and electricity duty has not been included here.

Table 2 Slab wise sales of distribution licensees for FY 2005-06[5]

Slabs	Sales (MU)				% of total
	BRPL	BYPL	NDPL	Total	
0-200 units	842	608	994	2443	40%
201-400 units	821	438	371	1630	27%
Above 400 units	1243	423	360	2026	33%
Total	**2905**	**1469**	**1725**	**6099**	

Source: Tariff petition filed by licensees for FY 2005-06

4 Based on actual figures for FY 2005-06 from the tariff petition filed by licensees
5 Excluding electricity duty

Table 3: Slab-wise revenue and average energy charge of distribution licensees

Slabs	Total Revenue (Rs. Cr)					Average energy charge
	BRPL	BYPL	NDPL	Total	% of total	Rs/unit
0-200 units	196	138	232	566	31%	2.32
201-400 units	238	125	132	495	27%	3.03
Above 400 units	467	149	159	775	42%	3.82
Total	901	412	522	1835		3.01

Source: Tariff petition filed by licensees for FY 2005-06

*Note: The revenue includes revenue from variable charges and excludes that from electricity duty and fixed charges

Another important point to mention here is that domestic consumers pay tariffs (Rs. 3.14 per unit inclusive of fixed charges) that are much lower than the average cost of supply. If we consider the voltage-wise costs and losses, the gap between the average cost of supply and average tariff further increases (Figure 6). The above implies that for every unit of electricity sold to a domestic consumer, the utility loses revenue, which affects its financial viability. This also results in increased pressure on subsidizing consumers viz. Commercial & Industrial due to presence of cross subsidy in the tariff structure.

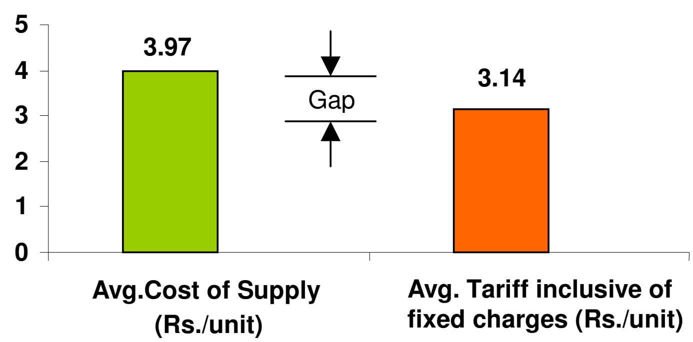

Figure 6 Gap between average cost of supply and average tariff (including fixed charges)

Estimated consumption from survey

One of the objectives of the survey was to gauge the usage pattern of households in different consumption slabs during a typical day. As per the estimates, around 35-45% of consumption is during peak hours (depending on the consumption slab) and rest during off-peak and normal hours. Table 4 highlights the consumption of a typical household during the day.

Table 4: Estimated yearly consumption (kWh) of a household from survey in selected areas

Slabs	Peak	Normal	Off-peak	Total	% in peak	% in Normal	% in Off-peak
0-200 units	455.3	168.8	389.1	1013.1	45%	17%	38%
201-400 units	999.1	713.6	1130.4	2843.1	35%	25%	40%
Above 400 units	1642.0	938.8	1527.3	4108.0	40%	23%	37%

Source: Survey estimates

In order to design ToD tariffs, the proportion of peak, off-peak and normal consumption as obtained from the survey has been applied on the actual sales for FY 2005-06. The break-up of actual usage during peak, off-peak and normal hours is indicated in Table 5.

Table 5 Breakup of present consumption during different time of day based on survey

	Consumption (MUs)			
Slabs	Total	Peak	Normal	Off-peak
0-200 units	2443	1098	407	938
201-400 units	1630	573	409	648
Above 400 units	2026	810	463	753
Total	6099	2481	1279	2340

Source: TERI analysis

Slab wise ToD tariff

The existing slab-wise average energy charge (actual) for domestic consumers is indicated in Table 6.

Table 6 Present slab-wise average energy charges for domestic consumers in Delhi

Slabs	Energy Charges (Rs./kWh)
0-200 units	2.32
201-400 units	3.03
Above 400 units	3.82

Source: Tariff petitions filed by the discoms

Keeping in mind the above rates, the next step in designing ToD tariffs is to arrive at the rates during peak, off peak and normal hours for each consumption slab. A common ToD tariff for all slabs may result in distortions with consumers in lower slab paying a higher tariff in comparison to the existing rates and those in higher slabs paying much lower. Thus, tariffs have to be designed so that there is a separate set of three different rates i.e. peak, off-peak and normal for each consumption slab.

Thus, for purpose of rationalising the impact on consumers of different consumption levels, ToD tariff is designed such that the revenue from each slab (Table 3 does not change. Also, the average energy charge in each slab remains the same. Further, the tariffs within a consumption slab cannot be telescopic in nature due to constraints in metering highlighted in the preceding section.

The ToD tariffs proposed are hence:

- **The proposed ToD tariffs shall be optional and alternate tariff plan. This shall be offered to consumer on voluntary basis i.e. shall be non-mandatory**
- **Non-telescopic in nature (due to metering and billing constraints)**
- **There are three rates – peak, normal and off-peak for consumers under three-consumption levels– Low (0-200 units); Medium (201-400 units) and High (Above 400 units)**
- **The fixed charges for consumers opting for ToD shall remain equivalent to the existing rates**

The rates for each slab have been simulated such that the normal and off-peak tariffs are lower than current average energy charge with peaks being significantly higher to provide a greater incentive to shift/move to energy efficient options. With this in mind tariffs were adjusted to also optimise for investment payback periods.

The rates have been chosen such, that there is no negative impact on the consumers, there is no revenue loss to the utility and rates at off-peak and normal hours are substantially less than the present average energy charge in that slab. The proposed rates are shown in Table 7. The overall average energy charge for each consumption slab under this structure is same as the existing average energy charge (Table 3)

Table 7 Proposed time of day tariff (energy charge) for different consumption slabs

Slabs	Peak	Normal	Off-peak	Average energy charge
0-200 units	3.20	1.85	1.50	2.32
201-400 units	4.50	2.50	2.10	3.03
Above 400 units	5.50	2.90	2.60	3.82

Source: TERI analysis

Figures 7, 8 and 9 highlight the tariff for different consumption slabs.

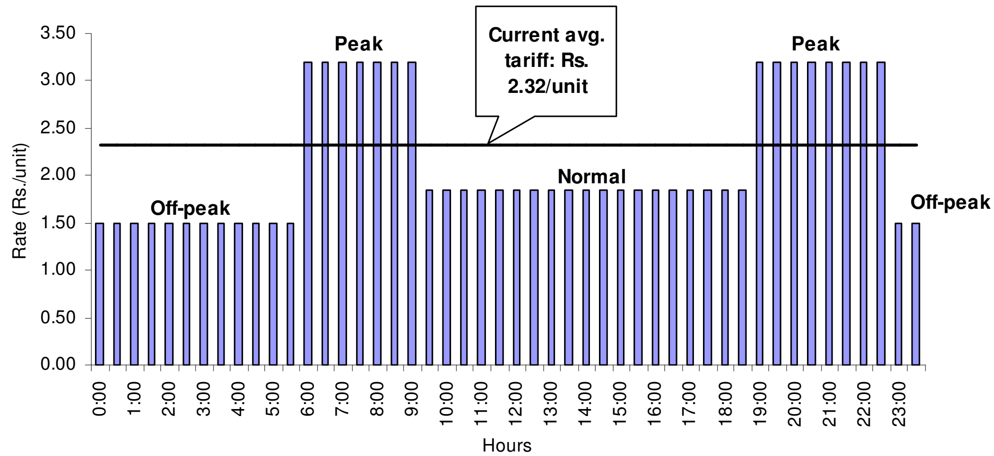

Figure 7 Low consumption slab (0-200 units)

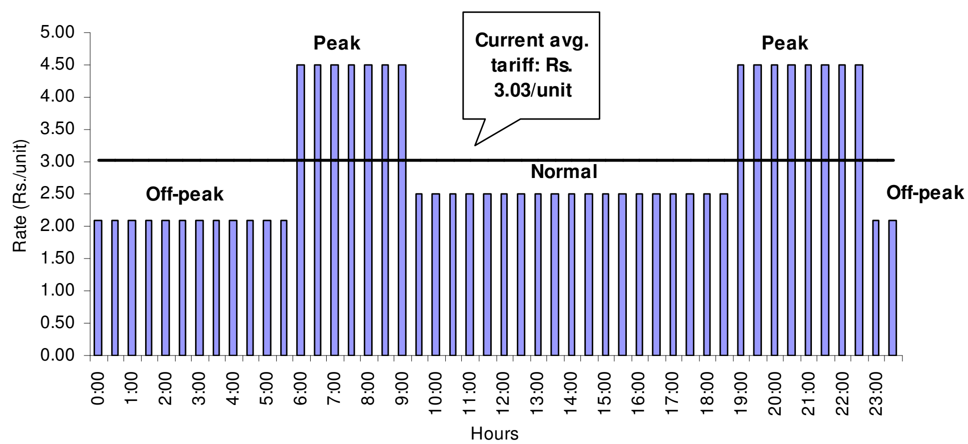

Figure 8 Medium consumption slab (201-400 units)

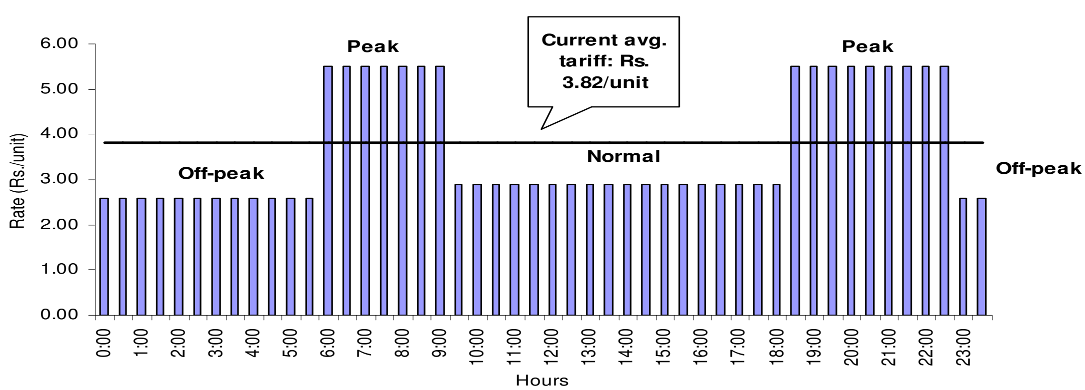

Figure9 High consumption slab (401 units and above)

Expected actions and impact

Some of the expected actions from consumers and utility to make the scheme successful, include the following: -

- **Consumers**
  a. Consumers to opt for time-of-day tariff plan based on their consumption level and pattern
  b. Replacement of incandescent bulbs and tube lights (along with chokes)
  c. Replacement of inefficient tube lights and copper chokes with electronic chokes
  d. Replacement of old fans and ACs with efficient appliances
  e. Shift usage
     i. Geysers from peak to off-peak – Using automatic timers (100%)
     ii. Other appliances like water pumps (25% shift), washing machine (50% shift) etc
- **Utility**
  a. Provide necessary metering/billing services to consumers who wish to opt for ToD tariffs

The impact of such actions on consumers and utility are discussed in following sections

Consumers

The investment and payback of various energy efficient appliances has been calculated and tabulated (Table 8)

Table 8 Investment and payback for energy efficiency options

EE Option	Existing price (Rs)	Usage (hrs/day)	Payback with existing tariff	Payback under ToD	Incremental payback* under ToD	Life (Years)
Bulb to CFL	90	6	3.6 months	2.9 months	2.6 months	3
Old TLs with EE Tls	460	6	2.5 yrs	1.7 yrs	1.5 yrs	8
Old fan with EE fans	1585	12 (8 months)	7.2 yrs	4 yrs	4.6 months	10-15
Old AC with EE AC	13500	8 (4-5 months)	10 yrs	4.7 yrs	11 months	10-15

Source: TERI analysis

*Incremental payback indicates the payback of additional cost spent on energy efficient options in ase of new purchases

Consumer Savings Under ToD Tariffs

In order to estimate the impact of such measures on the total expenditure of the consumers, consumption of selected few appliances have been considered[6] accounting for ~80% of consumption. The change in consumer expenditure by using efficient appliances but without any shift in consumption pattern is shown in Table 9. Table 10 highlights the savings when consumers change their consumption pattern as per the following: -

- 100% shift of geysers from peak to off peak hours by use of automatic timers
- 25% shift of water pumps from peak to off peak hours
- 50% shift of washing machines from peak to normal hours

Table 9 Consumer savings by using EE appliances and no change in usage pattern

Slabs	Current expenditure (Rs/month)	New expenditure (Rs/month)	Savings (approx. % reduction)
0-200 units	196	149	24%
201-400 units	725	513	29%
Above 400 units	1308	1042	20%

Source: TERI analysis

Table 10: Consumer savings by using EE appliances and change in usage pattern

Slabs	Current expenditure (Rs/month)	New expenditure (Rs/month)	Savings (approx. % reduction)
0-200 units	196	138	30%
201-400 units	725	502	31%
Above 400 units	1308	916	30%

Source: TERI analysis

In addition to the above, consumer who change their appliances to energy efficient ones, will also witness a reduction in their overall demand/load. This may result in additional benefit by reduction in the fixed charges to the consumer as it is based on the sanctioned/connected load of the consumer. This however, has not been considered in the above savings and would be in addition to the above benefits.

Utility

While estimating the impact on utility, following aspects have been considered

- Revenue loss to utility due to lower sales on account of use of energy efficient appliances
- Revenue gain due to overall reduction in power procurement

6 Bulbs, fluorescent tubes (TLs), CFLs, Fan, Cooler, AC, Geyser, Washing Machine, Water Pump, which reasonably constitute majority of the high use appliances used at the consumer end.

- Revenue loss to utility due to shift and higher usage at lower tariff and lower usage at higher tariff
- Revenue gain due to lower power procurement during peak hours at higher rate

The summary of total impact on the utility is shown in Table 11.

Table 11: Impact of Time of Day tariff on utility (per household)

	Consumption slabs		
Description	0-200 units	201-400 units	Above 400 units
	Rs.	Rs.	Rs.
Yearly revenue loss due to reduced sales (Rs.)	936	2588	4612
Yearly revenue gain due to reduced power purchase[7] (Rs.)	2051	3810	5672
Yearly revenue gain due to reduction in cross subsidy (Rs.)	396	651	136
Net yearly gain (Rs.)	1511	1872	1195
Total monthly gain per household (Rs./month/household)	126	156	100
Peak load saving (kW) by EE and shifting (kW per household)	0.82	2.90	4.24

Source: TERI analysis

As seen from the above, the monthly gain to the utility for the highest consumption slab is less as at higher levels of consumption the difference between the average cost of supply and the average tariff reduces.

Consumer perceptions and willingness- Survey findings

Data collected from the survey in selected areas of Delhi was analysed in order to understand the ownership and usage pattern of electrical appliances in households, to gauge the awareness level with regard to energy efficiency and the willingness to reduce/shift consumption under differential pricing regime.

Ownership of appliances and average usage

Survey was undertaken in three areas of Delhi viz. Vikas Puri H, H1, H2 and H3 Blocks, IP Extension, Rohini Sector 9. The average ownership of appliance per household and average usage pattern of these appliances across these areas is given in Table 12.

7 Assuming cost of procuring power at Peak: Rs. 6.50/unit; Normal: Rs. 4.50/unit; Off-peak: Rs. 2.10/unit

Table 12 Ownership and Usage of Various Household Appliances

Appliance	Ownership (No./household)	Usage (Hours per day)	Months/year
Bulb	1.3	1.6	12
Tube light	5.3	2.7	12
CFL	3.0	2.4	12
Fan	4.5	7.8	8
Cooler	0.9	9.6	6
AC	1	6.4	3-5
Washing Machine	1	3	9
Water Pump	0.4	2.1	12
Television	1.6	6.7	12
Geyser	1	1.9	3

Usage during different time periods of the day

Usage of various electrical appliances during a typical day month is given in Table 13.

Table 13 Percentage Usage during the day

Appliance	%Usage in peak hours	%Usage in normal hours	%Usage in off-peak hours
Fan	37%	34%	29%
Cooler	24%	50%	26%
AC	9%	64%	26%
Washing Machine	70%	3%	27%
Water Pump	84%	7%	9%
Television	50%	20%	30%
Geyser	81%	4%	14%

As seen from the above, a significant percentage of usage of various appliances is during off-peak and normal hours. Since tariffs will be lower in these two time slots, it may result in savings to the consumers. An appropriate design of ToD tariff shall enable the consumer to offset increase in electricity expenditure during peak hours with savings during off-peak and normal hours. Alongside this, appropriate pricing will also provide the right signals to consumer to shift to off-peak periods / reduce consumption during peak hours and to move towards more energy efficient appliances. Accumulated impact of this would lead to a flattening of Delhi's load curve.

Specific observations regarding type of appliances used in the three areas are highlighted below: -

Tube lights

Majority of the tube lights used in these areas are conventional 40 W tube lights and~ 50% operate on electronic chokes.

- In Vikas Puri, 91% are 40 W and 51% operate on electronic chokes
- In Rohini, 95% are 40 W and 46% operate on electronic chokes

- In IP Extension, 78% are 40 W and 57% operate on electronic chokes

Fans

Almost all fans used in these areas are branded and ISI marked. Majority operate with electronic regulators[8] and have never been rewound.

- In Vikas Puri, 99% are branded, 98% ISI marked, 51% operate with electronic regulator and 90% have never been rewound.
- In Rohini, 98% are branded, 96% ISI marked, 58% operate with electronic regulator and 93% have never been rewound.
- In IP Extension, 100% are branded, 73% are ISI marked, 84% operate with electronic regulator and 95% have never been rewound.

Coolers

Majority of coolers used in these areas are branded and medium sized. Also most of them are more than 2 years old.

- In Vikas Puri, 45% are branded, 82% medium sized and 41% have submersible9 type cooler pumps.
- In Rohini, 86% are branded, 82% medium sized and only 64% have conventional type cooler pumps.
- In IP Extension, 90% are branded, 87% medium sized and 42% have submersible type cooler pumps.

Air Conditioners

Majority of ACs used in these areas are branded and window type. Also most of them are of 1.5 ton.

- In Vikas Puri, 95% are branded, 91% window type and 45% are of 1.5 ton.
- In Rohini, 97% are branded, 94% window type and 74% are of 1.5 ton.
- In IP Extension, 98% are branded, 86% window type and 80% are of 1.5 ton.

Geysers

Majority of Geysers used in these areas are branded and storage type. None, except one use solar water heating system (SWHS)

Awareness

In order to gauge the existing level of awareness of the consumers in the selected areas several questions were asked from them during the survey. These included i) various energy efficiency options adopted by the household, ii) awareness about the CFL scheme offered by the

8 Electronic Regulators improve the efficiency of fans at lower speed as compared to conventional regulator.
9 Submersible pumps in coolers are more efficient than conventional pumps.

discoms3 and iii) awareness about BEE star rating on air conditioners and refrigerators etc. Following points emerged from the analysis of the survey data: -

Lighting

- Around 65% of the households in the sample were aware of energy saving options in lighting and had taken one or the other measure in this respect.
- Awareness about the discoms scheme on CFLs was low. In Vikaspuri only 25% of the households were aware of the scheme. This percentage in IP Extension and Rohini was 43% and 27% respectively. However, majority of consumer who had availed the scheme were satisfied with the quality of the product offered.

Space Conditioning

- Awareness with respect to energy saving options in space conditioning was low. Majority of consumers were unaware about star rating in ACs and refrigerators This is highlighted in Figure 10: -

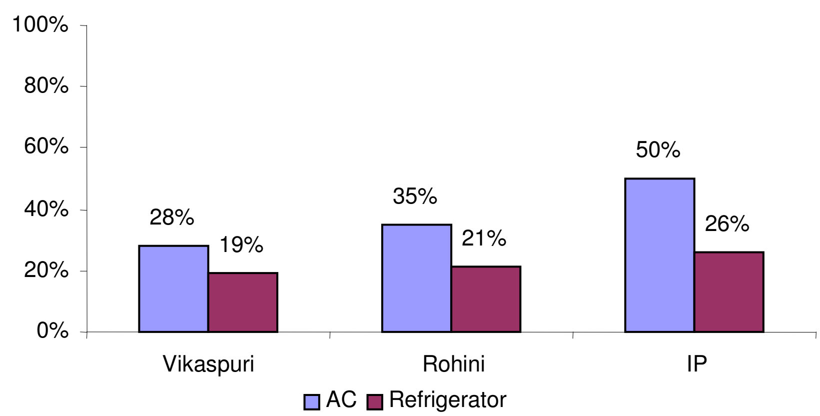

Figure 10 Level of awareness of BEE Star ratings in ACs and Refrigerators.

Willingness

During the interview, the basic concept of time-of-day tariff was explained to the consumers and they were asked whether under such regime would they be willing to shift usage of various appliances from peak to off peak hours and reduce consumption of the same. Various questions were also asked to gauge the willingness of the households to purchase energy efficient appliances. Following points emerge from the analysis of the results obtained from the survey: -

3 BSES Scheme: Buy one get one free and NDPL Scheme: Buy two get one free

- Majority of the households are willing to reduce and shift the consumption of AC and Geyser in the presence of time of day tariffs (ToD). The respective percentages area-wise are highlighted in Figure 11: -

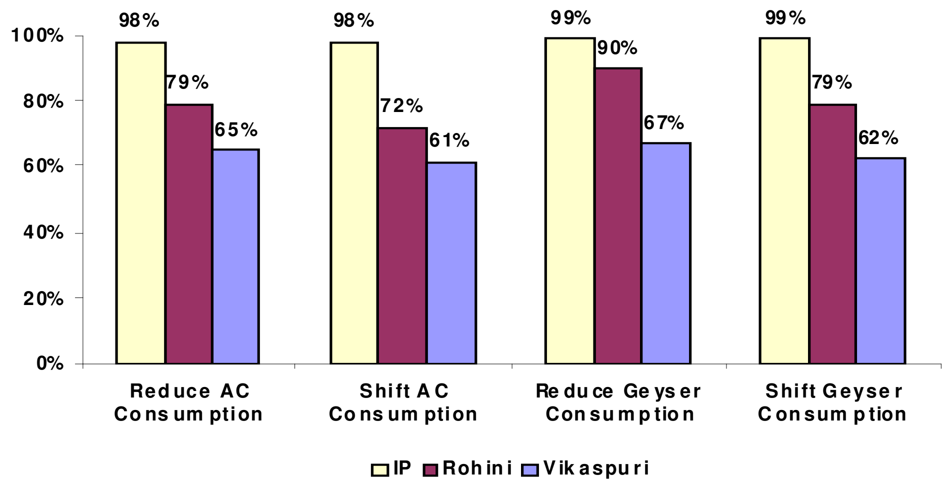

Figure 11 Willingness to shift and reduce AC and Geyser Consumption

- Other Appliances: Washing machines, electric irons, and water pumps are high power rating and low usage appliances, used intermittently during the day. Though they do not contribute significantly to the total electricity consumption, if used during peak hours, they can increase the peak demand significantly. It was observed that majority of households are also willing to shift the consumption of these appliances during the off-peak hours.

- Majority of households believe buying energy efficient tube lights and fans results in saving and are willing to purchase the same. This is depicted in the Figure 12: -

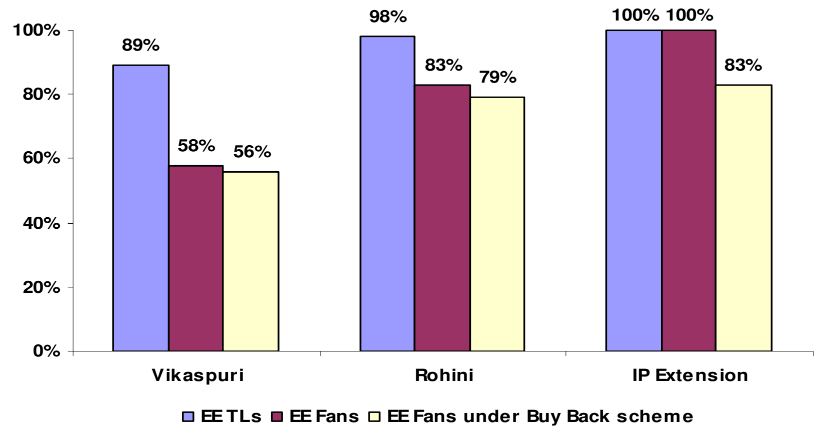

Figure 12 Willingness to purchase energy efficient products

To summarize, it is evident from the above analysis that there exists a high level of awareness among the respondents about efficiency options in lighting. However, in case of water heating and other end uses (like use of washing machine, space conditioning and so on), awareness is very low. Some reasons for the same are high initial cost, unavailability of financing schemes, and resistance to change. Other major barrier is lack of interest among consumers, which is primarily because of uncertainty regarding savings.

Additional contribution

In addition to the benefits that consumers and discoms will get from energy savings and reduced power procurement respectively, TERI along with GoNCTD is making efforts to further improve the scheme to make it attractive to the consumers.

Dialogue with manufacturers and banks

- TERI along with GoNCTD is in talks with various appliance manufactures to explore the possibility of offering discount/attractive offers and best prices on energy efficient appliances.
- It is also exploring possibility of low interest loans from banks for financing replacement of costly items like air conditioners.

Alternative use of subsidy available for solar water heaters as monthly rebate for time-of-day tariffs

GoNCTD in order to promote the usage of Solar Water Heating System (SWHS) provides a cost subsidy of Rs. 6000 per consumer for domestic consumers only. Loan facilities for installation of SWHS are also available with several banks. Table 14 shows the impact of extending this subsidy scheme to energy efficiency interventions in terms of watts saved per rupee of subsidy. The GoNCTD subject to cabinet approval is willing to extend this subsidy to households who opt for ToD tariffs. However, for ease of administration they propose to offer this in the form of monthly rebate to consumer opting for ToD for a limited time period.

A detailed analysis of replacement of various appliances and its impact in terms of wattage reduction per rupee invested in presented in Table 14.

Table 14 Impact of replacement of various appliances

Appliance	Wattage reduction per appliance replacement	Ownership per household	Total Wattage Reduction during peak	Amount proposed to be invested by Delhi Govt.	Watt saved per rupee invested
	W	Nos./household	W	Rs.	W/Rupee
Energy efficient tube lights with electronic chokes	27	5.3	142	1052	0.14
Energy efficient fans	25	4.5	113	1125	0.10
Air Conditioners	770	1.0	801	3120	0.26
Timers for geysers	1500	1.0	873*	700	1.25 @60% load shift
Total			***1988***	***5997***	***0.33***
SWHS	**1500**	**1.0**	**1455**	**6000**	**0.24**

As seen from Table 14, the watt saved per rupee is much higher in case of the replacements of other appliances and installation of automatic timers for geysers than installation of SWHS. Here it is assumed that in case of geysers only 60% load gets shifted. If there is 100% shift of geyser load to off-peak periods by use of automatic timers, the total watt saved per rupee invested becomes 0.43 (instead of 0.33), i.e. substantially higher than that of SWHS. While a subsidy program for SWHS is commendable more so for environmental reasons, given the challenges of reducing the demand supply gap it may be useful to provide incentives for other measures also.

As seen from the above, investments in other appliances lead to a larger impact than SWHS. In addition to this the following points may be noted: -

- Geyser is used only for 3 months in a year, while other appliances are used almost throughout the year
- Use of SWHS does not address peak problem, as peak is more prominent in summer months. It also does not guarantee replacement and hence load reduction as households tends to use it along with geysers as backup.
- Willingness & acceptability to opt for SWHS is relatively lower due to various reasons like space constraints, piping requirements, problems related to scaling etc.

The above table demonstrates impact and effectiveness of subsidy, based on various assumptions 11. However, there are several reasons that justify and prove that a rebate on monthly bill would be better form of delivering the above subsidy than to provide an upfront lump sum payment. These are discussed below:

Why not appliance subsidy?
The primary reason for not targeting the above subsidy to different appliances is because it would then unnecessarily encourage additional purchase of appliances causing an increase in the load. While rebate on bill facilitates replacement of old appliances with efficient ones, appliance subsidy facilitates new purchases and hence contribute towards increasing the load.

With the above in view, subsidy has been kept in the form of monthly rebate on electricity bill of consumers who opt for ToD tariffs. Not only will this remove the initial barrier and encourage the consumer but also its administration and monitoring is easy as it avoids detailed verification of appliances replaced at consumer end.

The above however, does not include timers for shifting geyser usage, which it is felt should be provided upfront to consumer who shift to ToD tariffs.

Why monthly rebate instead of lump sum upfront subsidy?
Since the plan for ToD tariff is voluntary in nature, consumers can subscribe or unsubscribe for the plan at their own will. A lump sum upfront subsidy lacks targeting as consumers may avail subsidy and then withdraw from ToD plan. Having a lock in period for consumer who shift to ToD tariff can check this, however it would act as a perceived barrier to move towards ToD tariff plan. Hence, it was decided to have a monthly rebate and keep option of ToD tariff voluntary. This would hence prevent the subsidy leakage and would result in better targeting.

[11] The calculations are based on average ownership of three areas and assuming a subsidy of Rs. 200 per tube light; Rs. 250 per fan; Rs. 3000 for AC replacement and Rs. 700 for timers. This is an assumption.