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Time of the Day based Demand Side Management for Cost Optimization

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***Abstract*— The need for electrical energy is peaking. As the resources are limited the effective utilization of the energy is essential. Demand side management plays a vital role in this context. It is the modification of energy demand by the consumer either by financial incentives or by education. Many of the countries successfully tried time of the day pricing method for implementing demand side management. This paper mainly focusing on the development of an algorithm which will help to optimize the cost where the time of the day based demand side managemt is used.**

Keywords—Optimization; Demand Side Management; Time of the Day Tariff;

I. INTRODUCTION

The traditional model of our power system is unidirectional. The advancement in the communication and control systems enables us to control the loads with greater degree of flexibility. The demand for electricity is increasing day by day. Even if we forget the constraints in the generation the next important thing is the grid capacity. In near future the grids might soon face their maximum limit. No solutions for this condition until and unless we further enhance the capacity of the grid. But in another way we can delay it by using intelligent demand side management techniques [1]. Demand Side Management is the process of intentionally modifying the demand from the user side by providing financial incentives or education [2]. Previously it was utility driven, it might become partially a customer driven in the near future.

There are different types of DSM techniques being used. One is Direct Load Control (DLC). It is the method in which loads are directly shed by the utility, based on an agreement with the user [3]. Another method is known as smart pricing where the user is voluntarily manage his load in order to reduce their consumption during peak times [4]. In this regard various types of pricing are available such as Critical peak pricing (CPP), Time Of the Day pricing (TOD), Real Time Pricing(RTP) etc. In the Time of the Day pricing method the consumers have to pay more for energy during peak hours and comparatively less in off peak hours. Considerable amount of savings can be made in such a system if the loads are shifted in a specific manner. This paper mainly focusing on developing an algorighm which will felicitate the shifting of loads with minimum level of inconvenience and there by optimizing the cost. The whole paper will be divided in to three parts. II section will be containing the load details and load curves of a typical 3 BHK flat. The III section the development of the algorithm is discussed and the last section will be containing the conclusions and the future scopes of this study.

II. LOAD DETAILS OF A TYPICAL 3 BHK FLAT

For the analysis, the load details of a typical 3 BHK flat is considered and the cost of energy over one month period is calculated.

TABLE I. LOAD DETAILS AND COST CALCULATION

Time slots	Components	Units Consumed
12AM-1AM	3 AC	3.5
1AM-2AM	3 AC	3.5
2AM-3AM	3 AC	3.5
3AM-4AM	3 AC	3.5
4AM-5AM	3 AC	3.5
5AM-6AM	2 AC, 2Tubes, Heater, 1Fan	3.66
6AM-7AM	2Fan, Induction cooker, 1Tube, 1Mixer, Microwave, Water Pump, Heater,	6.696
7AM-8AM	TV, 2 Heaters, Iron box	4.15
8AM-9AM	Fridge	0.5
9AM-10AM	Fridge	0.5
10AM-11AM	Fridge	0.5
11AM-12PM	Washing machine, Vacuum cleaner, Induction cooker, Mixer, 1Fan	4.53
12PM-1PM	1Fan, TV,	0.73
1PM-2PM	1Fan, TV	0.73
2PM-3PM	1AC	1.5
3PM-4PM	1AC	1.5
4PM-5PM	Dishwasher, Water pump,	2.746
5PM-6PM	TV, Music system, Computer, 2 Fans,	2.11
6PM-7PM	6Tubes,2 CFL, TV, Computer, Music system, Mixer, Grinder	3.599
7PM-8PM	6Tubes, 2CFL, Induction cooker, TV, Computer, 2Fans	3.434
8PM-9PM	4Tubes, 2CFL, 1Fan, TV	0.974
9PM-10PM	Dishwasher, 2CFL,2 Tubes, Computer, TV	4.464
10PM-11PM	Table lamp, Computer, 2AC, 1Fan	2.92
11PM-12PM	3 AC,	3.5
	Total units consumed in one month	1987.29
	Total cost in one month	11282 Rs

Table II shows the rate schedule used for the energy cost calculation.

TABLE II. RATE SCHEDULE

Fixed charges per month	For the 1st KW	Rs 25/-per KW
	For the additional KW	Rs 35/-per KW
Energy charges per month	0-30 Units	250 ps/unit
	31-100 Units	370 ps/unit
	101-200Units	485 ps/unit
	Above 200 units	585 ps/unit

C. Equations

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Fig. 1 shows the daily load curve of the flat.

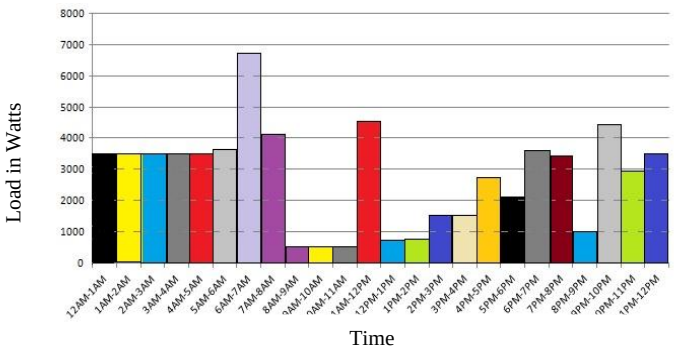

Fig. 1. Load curve of a 3 BHK flat

For the developemnt of the algorithm few assumptions are taken. The over all time frame will be either lies in peak period or off peak period.And the energy prices in the peak time is assumed to be 3 times that during the off peak time. Fig. 2 shows the cost curve based on the TOD pricing.

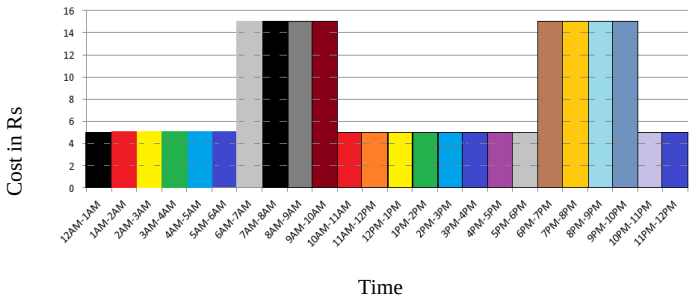

Fig. 2. Cost curve based on the TOD tariff

III .ALGORITHM

From the load curves and cost curves it is obvious that during peak hours the customer have to pay more money rather than during the off peak hours. A few constraints have to be keep in mind before the scheduling of the loads. The scheduling should results minimum possible inconvenience to the customer. And if two possible time slots are found feasible importance should be given to the first time slot.

Fig. 3 shows the time during which energy cost will be more where the load scheduling algorithm can be used.

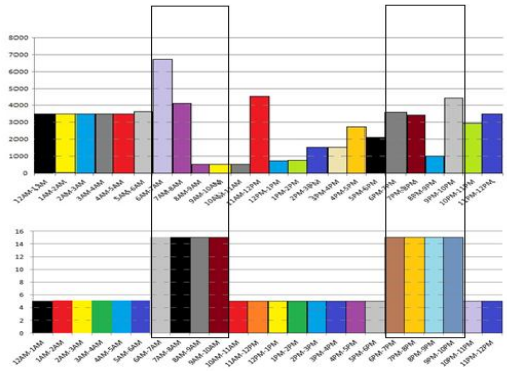

Fig. 3. Figure showing the time slots in which the loads have to be rescheduled

For the scheduling of the loads the following steps are used

Step 1. Figure out the shiftable loads (non critical loads)

Step 2.Specify the earlier start time and late start time of the equipments

Step 3: Check whether the loads can be shifted

Step 4: Shift the loads if possible and calculate the savings

Keep in mind all loads are not readily shiftable. Consider the case of a lighting load and a geyser. Comparing with a geyser lighting load is not readily shift able. During off peak period the water can be heated. But the lighting loads have to be kept on as long as there is lack of light experienced. The earlier start time and the late start time specify the time span in which the load can be re-distributed. To find out the rescheduling of the load is possible or not the following steps can be adopted.

Step 1: Calculate the energy cost per hour based on flat rate tariff and TOD tariff

Step 2: Compare both, if TOD tariff is higher than that of flat rate tariff consider the earlier start time and late start time of the equipment

Step 3: Calculate the time slot for rescheduling using the following equation

Scheduled time=(LST- EST)- (Peak price period)

where LST is late Start Time and EST is Earlier Start Time.

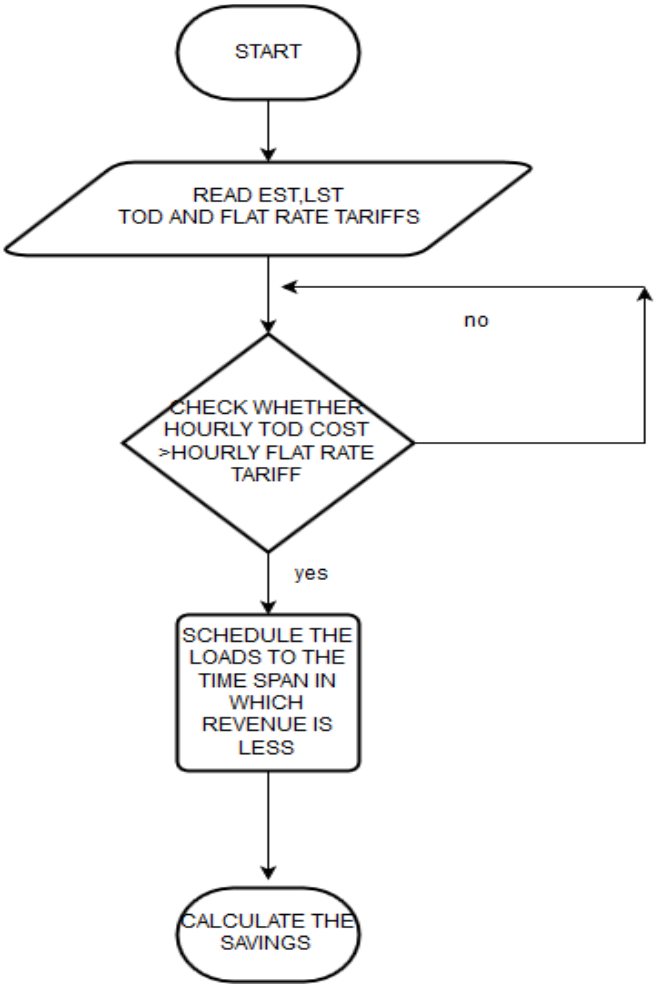

Fig. 4. Flow Chart for the given algorithm

IV .CONCLUSION

A novel method for the time of the day based demand side management is developed. By considering the smaller time spans and by prioritizing the loads a more convenient load scheduling can be achieved.

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