ELECTRICITY CONSUMPTION PATTERNS IN DOMESTIC HOUSE HOLDS.

H. Kadete

Dept. of Electrical Engineering, University of Dar es Salaam,
P.O. Box 35131, Dar es Salaam, Tanzania

ABSTRACT

Electricity tariff increases from 1988 to 1992 are presented. They are compared with salaries paid to parastatal workers over the same period. Monthly expenditures on electricity are also presented. Electricity consumption profiles have been recorded. The typical end use electrical appliances for each household category have been identified. About 69% of electricity is used for cooking in high demand households. In medium demand households electricity used for lighting dominates at about 49%. Measurements indicate a 3 peak power consumption profile for domestic dwellings. Voltages of 180V were recorded instead of the expected 230V nominal. Power factor is not a problem in domestic dwellings.

INTRODUCTION

The quality of electricity supplied is bad [1]. The domestic consumption patterns are not adequately documented in Tanzania. Knowledge of domestic profiles help to formulate demand-side management, time of use electricity tariffs, and are basic in after diversity maximum demand forecasting [2,3,4]. Voltage profiles assist in determing the quality of supply, power factor measurement, and help us to ascertain whether we need power compensation or not. In this paper, voltage, power, power factor, and current profiles for high and medium demand are being presented.

SALARIES AND ELECTRICITY BILLS

The electricity bill to the consumer is becoming increasingly unbearable. This is verified if we look at the historical development of the electricity tariff for the domestic consumer category displayed in Table 1 and compare it with the historical development of parastatal salaries over the period 1987 to 1992 displayed in Table 2. The periods indicated in column 1 of Table 2 were selected those which correspond to the dates in Table 3. Table 3 indicates a broad categorization of consumers and Table 4 displays a computation of what these broad categories pay monthly on average as electricity bills.

Table 1 : Tarifs

S/N PERIOD	BLOCK	CONSUMPTION	ENERGY CHARGE	SERVICE CHARGE
		kWh	Tshs per kWh	Tshs per meter reading period
1. JANUARY 1988		0 - 100	0.6	15
		101 - 1000	0.75	15
TO		1001 - 2500	1.5	15
		2501 - 7500	8.5	15
JULY 1988		OVER 7500	15	15
2. JUNE 1989		0 - 100	0.75	25
		101 - 1000	1	25
TO		1001 - 2500	4	100
		2501 - 7500	8	100
DECEMBER 1989		OVER 7500	17	100
3. JULY 1990		0 - 100	0.85	50
		101 - 1000	1.25	50
TO		1001 - 2500	7.5	200
		2501 - 7500	55	200
DECEMBER 1990		OVER 7500	55	200
4. JULY 1991	0 - 100	0 - 100	2	75
	101 - 1000	0 - 1000	3	75
TO	1001 - 2500	0 - 1000	3	75
		1001 - 2500	7	300
DECEMBER 1991	2501 - 7500	0 - 1000	7	300
		1001 - 2500	17	300
		2501 - 7500	35	300
	OVER 7500	0 - 1000	7	300
		1001 - 2500	17	300
		2501 - 7501	35	300
		OVER 7500	15	300
5. JANUARY 1993	0 - 100	0 - 100	3	100
	101 - 7500	0 - 1000	5	100
TO		1001 - 2500	12.5	500
		2501 - 7500	25	500
FEBRUARY 1994	OVER 7500	0 - 1000	12.5	500
		1001 - 7500	35	500
		OVER 7500	50	500

Table 2: Monthly salaries for Parastatal emplyees

	Minimum	Income	Medium	Income	Maximum	Income
YEAR	Tshs	Scale	Tshs	Scale	Tshs	Scale
JULY 87	1,040	MSU1B/MIN	5,545	MSU7/MAX	7,370	MSU 14
JULY 88	1,275	MSU1B/MIN	6,200	MSU/MAX	8,110	MSU 14
JULY 89	1,770	POSI/MIN	8,840	PGS7/MAX	20,940	PSS 4/MAX
JULY 90	2,125	POS1/MIN	10,610	PGS7/MAX	25,130	PSS 4/MAX
JULY 91	3,670	POS1/MIN	13,870	PGS7/MAX	28,920	PSS 4/MAX
JULY 92	5,230	POS1/MIN	16,285	PGS7/MAX	33,265	PSS 4/MAX

In Table 2 above the minimum incomes, middle range incomes, and maximum incomes for parastatal employees from July 1987 to July 1992 are presented. The lowest incomes are the minimum salaries in the lowest range MSU 1B for 1987 and 1988 and POS1 for 1988 to 1992. The middle range incomes are the maximum salaries in the category MSU 7 and PGS 7 respectively. The highest salaries are those for MSU 14 and maxima in PSS 4 scale.

Now electricity consumption wise a person with minimum income is expected to occupy a low demand household. A person with medium income is expected to occupy a medium demand household while a person with high income may be expected to occupy a high demand household. Surveys by the author have indicated that electricity consumption distribution can be categorised as depicted in Table 3.

Table 3: Electricity consumption distribution

S/N	TYPE OF HOUSEHOLD	AVERAGE MONTHLY CONSUMPTION
	(Distribution)	(kwh/month)
1.	Low demand	100
2.	Medium demand	1000
3	High demand	5000

Table 4: Comparison of average monthly incomes to typical monthly electricity bills for parastatal employees

	Low Demand 100 (kWh)		Medium Demand 1000 (kWh)		High Demand 5000 (kWh)	
Date	Income (Tshs)	Bill (Tshs)	Income (Tshs)	Bill (Tshs)	Income (Tshs)	Bill (Tshs)
JULY 87	1040	-	5,545	-	7,370	-
JULY 88	1275	75	6,200	750	8,110	24,250
JULY 89	1770	100	8,840	1,000	20,940	26,975
JULY 90	2125	135	1,0610	1,250	25,130	150,160
JULY 91	3670	275	13,870	2,975	28,920	120,300
JULY 92	5230	400	16,285	5,100	33,265	86,750

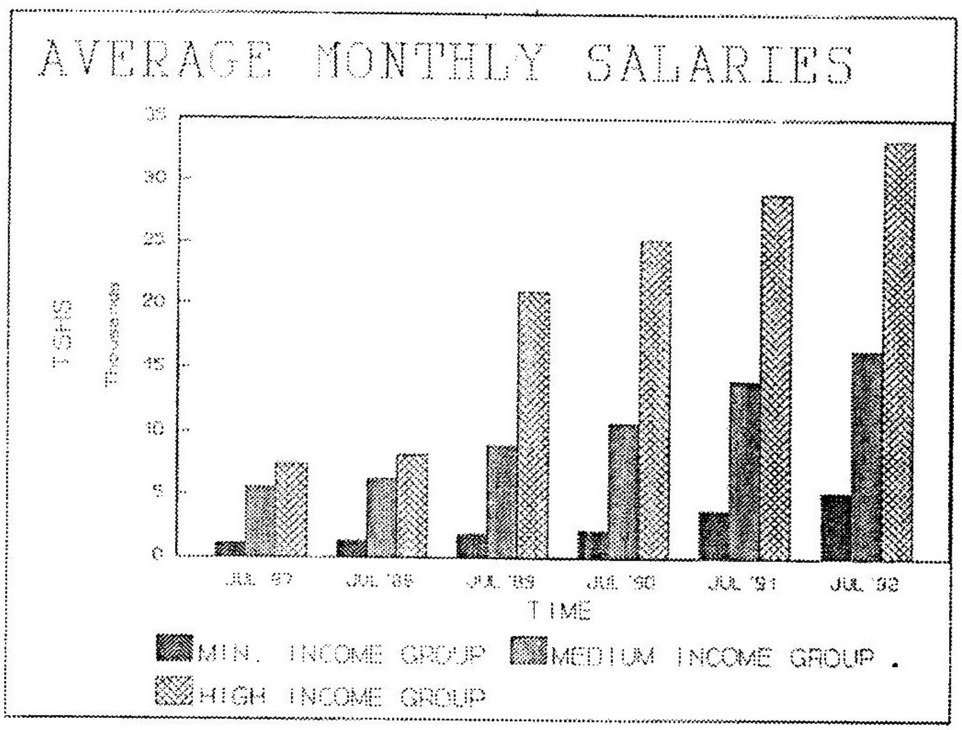

Fig. 1: Avearge monthly salaries

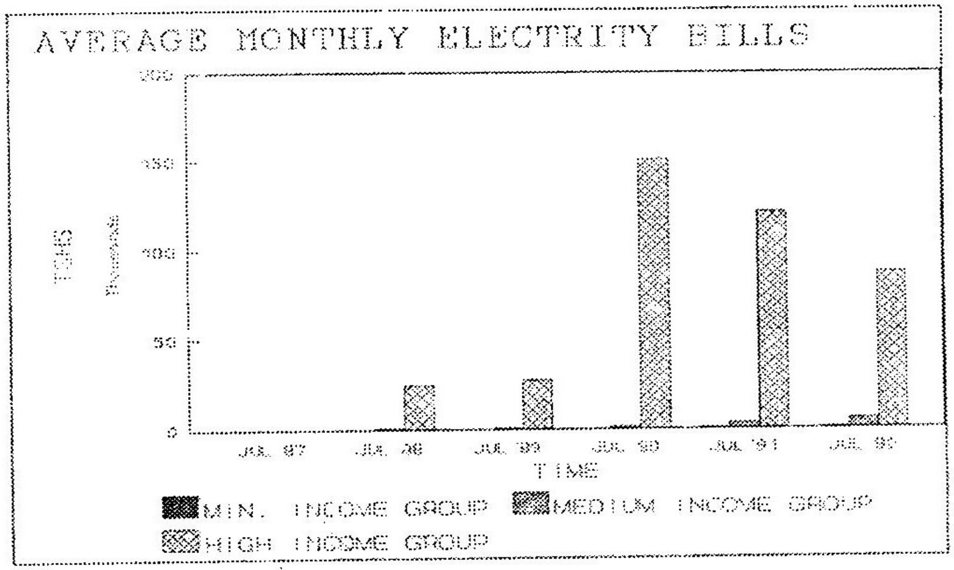

Fig. 2 Average monthly electricity bills

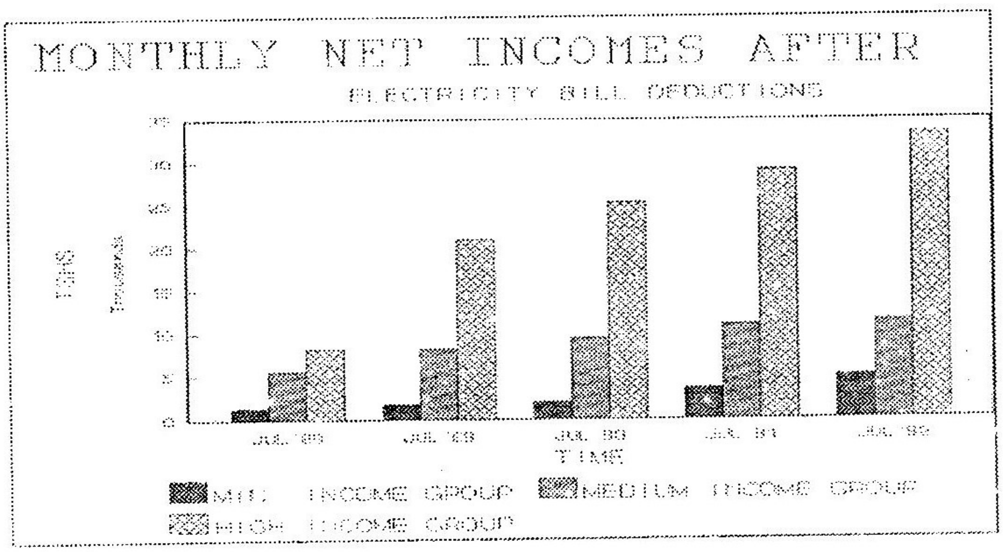

Fig. 3: Monthly net incomes after electricity bill deductions

In Fig. 3, for high income group if the electricity bill deductions were made from their salaries computed in Table 4, net income should appear as negative. However here in Fig. 3 it appears as positive because the high income group category pay their bills from allowances and not from their salaries.

ELECTRICITY CONSUMPTION PATTERNS

In Table 5 we describe the different types of end use devices which are typically found in these households as surveyed by the author.

Table 5: Electrical appliances distribution in households

S/N	TYPE OF HOUSEHOLD	TYPICAL ELECTRICAL APPLIANCES	
	(Description)	(Description)	(Units x Rating)
1.	Low demand	Lighting - Radio -	(1 x 60W) (1 x 20W)
2.	Medium demand	Lighting - Radio - TV/VCR - Cookers - Iron - Refrigerator - Deep freezer - Fans -	(20 x 100W) (1 x 20W) (1 x 50W) (1 x 3000W) (1 x 1000W) (1 x 100W) (1 x 200W) (2 x 100W)
3.	High demand	Lighting - Radio - TVS - VCR - Cookers - Iron - Refrigerators - Deep freezers - Air Conditioners - Water Heater -	(40 x 100W) (3 x 20W) (3 x 100W) (3 x 25W) (2 x 3000W) (2 x 1000W) (3 x 100W) (2 x 100W) (4 x 2000W) (2 x 3000W)

The typical load profiles for the households are depicted in Figures 4-7.

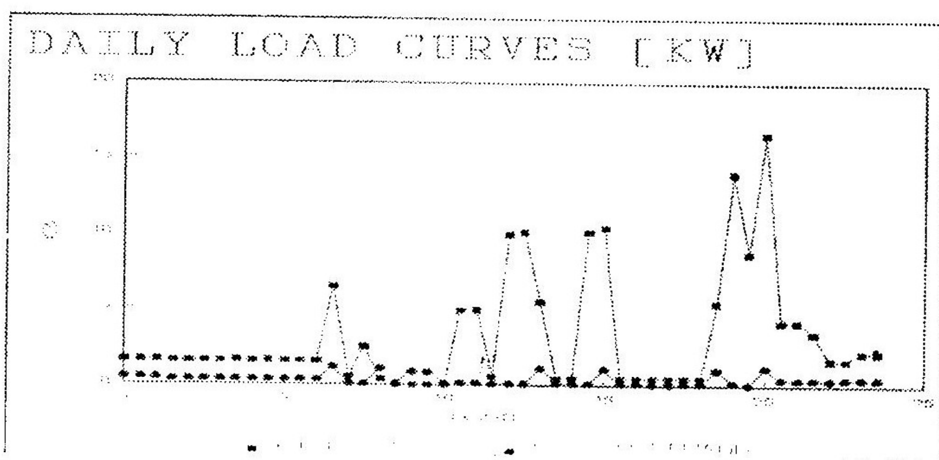

Fig. 4: Daily load curves (kW)

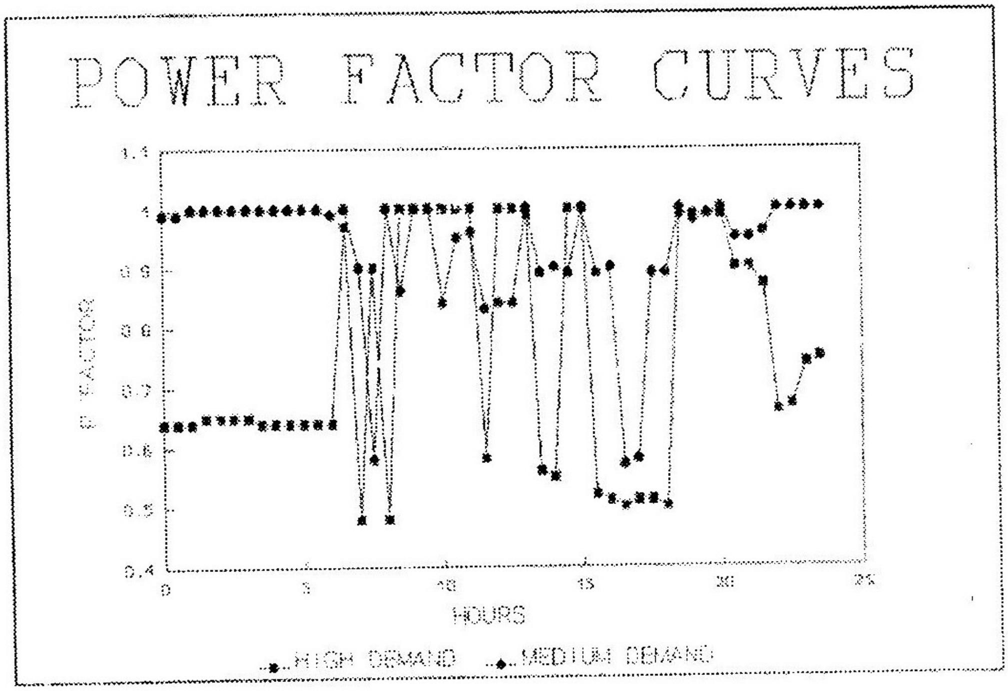

Fig. 5: Power factor curves

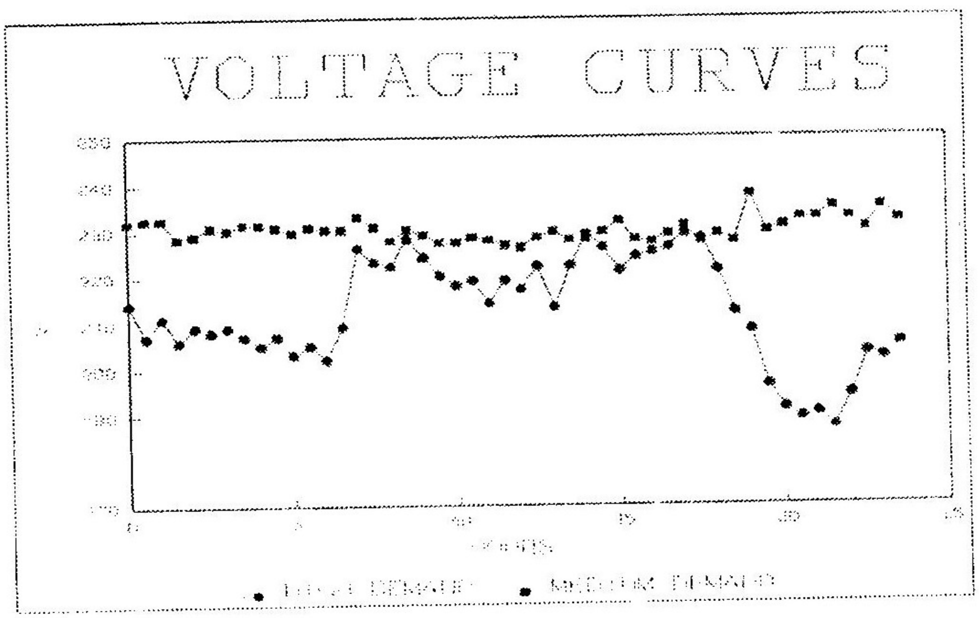

Fig. 6: Voltage curves

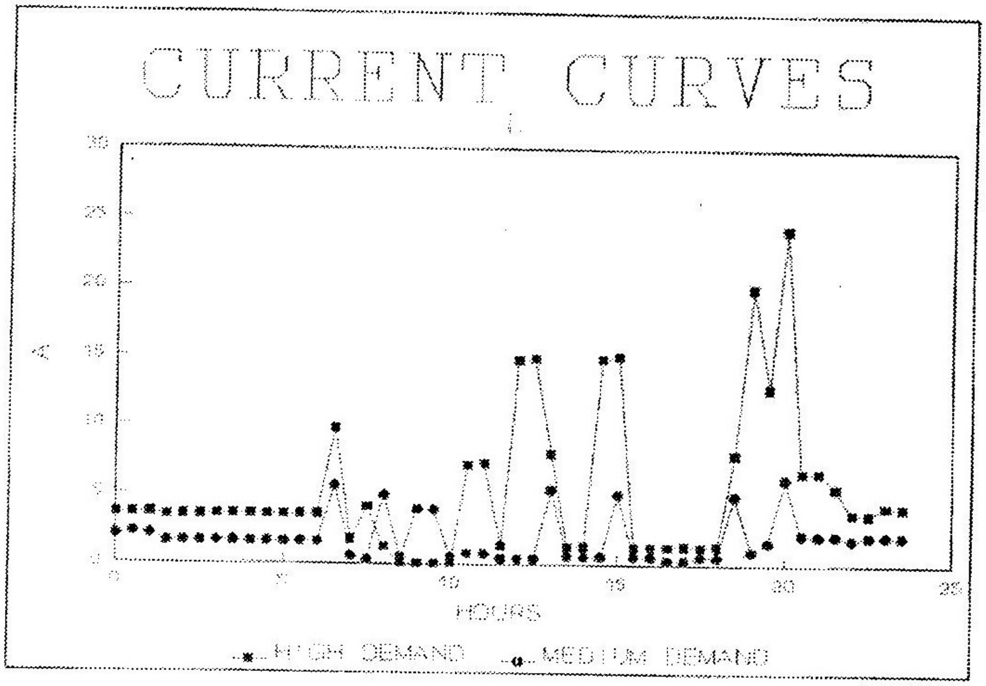

Fig 7: Current curves

Table 6: Consumption of electricity in medium demand household dissagragated by end use device

	KWh per day	Percent
Lighting	4.05	49
Cooking	3.534	43
Others	0.72	8
TOTAL	8.304	100

Table 7: Consumption of electricity in high demand household dissagragated by end use device

	KWh per day	Percent
Lighting	12	16
Cooking	51	69
Others	11	15
TOTAL	74	100

POSSIBILITIES TO REDUCE ELECTRICITY CONSUMPTION

Since the dominant use of electricity in domestic dwellings is in lighting, cooking and fans or air conditioning, the main thrust if one intends to use electricity economically is to use efficient lighting, efficient cooking appliances and whenever possible fans instead of air conditioners [5,6].

CONCLUSIONS

Due to low salaries low and medium income earners cannot increase their electricity use.

Domestic load profiles show a base load with three very pronounced peaks. First peak occurs at around 7 - 9 hrs during breakfast time. The second peak occurs between 10 - 15 hrs during lunch time and the third peak is between 18 - 22 hrs during evening meals. The first two peaks are caused by cooking. In the evening the peak is due to cooking and lighting. The base load is mainly due to fans, air conditioning, and other activities like ironing, video watching, radio or music system operation etc.

The lighting load causes a low power factor of the order of 0.5 - 0.65. However during the power consumption peak times the power factor ap proaches unity. There is practically no need for installation of any further power factor improvement devices or of introducing an additional low power factor penalty component to the domestic tariff.

Voltage profiles are not stable. The main problem is low voltage. There is therefore a need to introduce voltage controllers, regulators and stabilisers in the sub-distribution systems.

The dissagragation of power use in domestic dwellings indicates that for medium demand households lighting and cooking consume energy of the order of 49% and 43% respectively. For high demand households, cooking accounts for about 69% of electricity consumption.

Future work will look at the dissagragated power consumption in lighting, cooking, air conditioning, etc.

REFERENCES

1. Ngowi, D., T anzania: The Cost of Electricity Power Outages to the Economy, *Proceedings of The Institution of Engineers Tanzania, Annual Seminar,* September 1993, pp.77-86.
2. Jansen, M. and David L., Domestic Time-of-Use Tariffs as a Demand Side Management Tool, *Proceedings of the First Conference on the Domestic Use of Electrical Energy,* The South African Institute of Electrical Engineers, Cape Town 18-19th October 1993, pp. 26-32.
3. Pudney, D.S. and Dingley, C.E., Demand profile research at PE municipality, *Proceedings of the First Conference on the Domestic use of Electrical Energy*, The South African Institute of Engineers, Cape Town, 18-19th October 1993, pp. 33-37.
4. Crawford, P.J. and Dingley,C.E., Domestic Load Profiling in the Goodwood area July - November 1991, *Proceedings of the First Conference on the Domestic Use of Electrical Energy*, The South African Institute of Engineers, Cape Town 18-19th October 1993, pp.38-42.
5. Kadete, H., Lujara,N.K., Munthali, S.K. and Maanga, L.E. Energy Conservation for the Faculty of Engineering, University of Dar es Salaam, Faculty of Engineering, Department of Electrical Engi-

neering Internal Consultancy Report, March 1992.

6. Kadete, H., Lujara,N.K., Munthali, S.K., Cost Saving Alternatives in Electricity use for non Commercial/Industrial Institutions, *IET Newsletter*, Vol 3, No. 1, March 1993, pp.5-10.

ACKNOWLEDGEMENTS

I wish to thank the Faculty of Engineering for funding this research.