POWER SHEDDING EXPERIENCES AND LESSONS IN A TOWNSHIP

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ABSTRACT

This paper presents how power shedding by taking out one of the transformer high voltage fuses causes phase imbalance. And for the same electrical energy output generator fuel consumption with unbalanced phases is 125% of the fuel consumption with balanced phases. Furthermore it is shown that energy efficient lighting by use of energy efficient bulbs can reduce load shedding.

INTRODUCTION

Urambo district township was electrified in 1985. Financing of this project was provided by the Ministry of Communication and Works which donated three generator sets rated at 3 x 85 kW. Tanzania Electric Supply Company Limited (TANESCO) donated material required to erect a distribution system, and provided personnel to erect and commission the generating station and the distribution system free of charge. The potential consumers only paid for the installation of the service lines.

Since 1985, the power supply was run under the authority of the local government, that is, Urambo District Council (UDC). UDC was responsible for purchase of fuel, lubricants, spare parts and payment of salaries for the plant operators and distribution line maintenance personnel. The electricity tariff was set and revenue collected by UDC.

In January 1992 UDC pulled out of close management of the electric power supply system due to shortage of funds [1]. At this time a decision was made to give consumers the management and running of the electric power supply system. Therefore Urambo Electric Consumers Cooperative Soci-

ety Limited (UECCO) was formed. When UECCO took over the management of supplying electricity only one generator out of the three generators installed in 1985 was working. At the time, there were 121 consumers, with a peak demand exceeding the available power supply of 85 kW. Therefore power rationing was instituted.

DISTRIBUTION SYSTEM

The voltage from the generator(s) is first stepped up by the power transformer (500 kVA) from 400 volts to 11 kilovolts. As shown in figure 1, there are three distribution transformers, however only the Town and Boma transformers are currently in service. Customers initially connected to Police transformer are now connected to the Town transformer.

Load Shedding

UECCO was forced to institute load shedding because the peak demand of 125 kW was much higher than the available power of 85 kW. There were two places in the distribution system where load shedding could be implemented which were at the two transformer terminals.

However. the Boma transformer supplies power to the residences of the District Commissioner (DC), the District Executive Director (DED), the Police Officer Commanding the district (OCD) and other district heads of departments. Therefore it was decided not to load shed customers supplied by the Boma transformers due to importance of the users. Hence load shedding could only be done on the Town transformer. This was accomplished by physically taking out a high voltage fuse of one of the phases, causing the transformer to supply power to only two phases. To be fair to all customers connected to the Town transformer load shedding was done on one phase per day, the following day another phase was load shed, and on the day after, the third phase was load shed. Thereafter the procedure was repeated (see table 1). Note that the current indicated in table 1 is the total current supplied by the generator(s), that is, the sum of currents taken by both the Boma and the Town transformers.

UECCO instituted two tariff rates (both of them flat), one for domestic consumers and the other for commercial consumers. Low income domes-

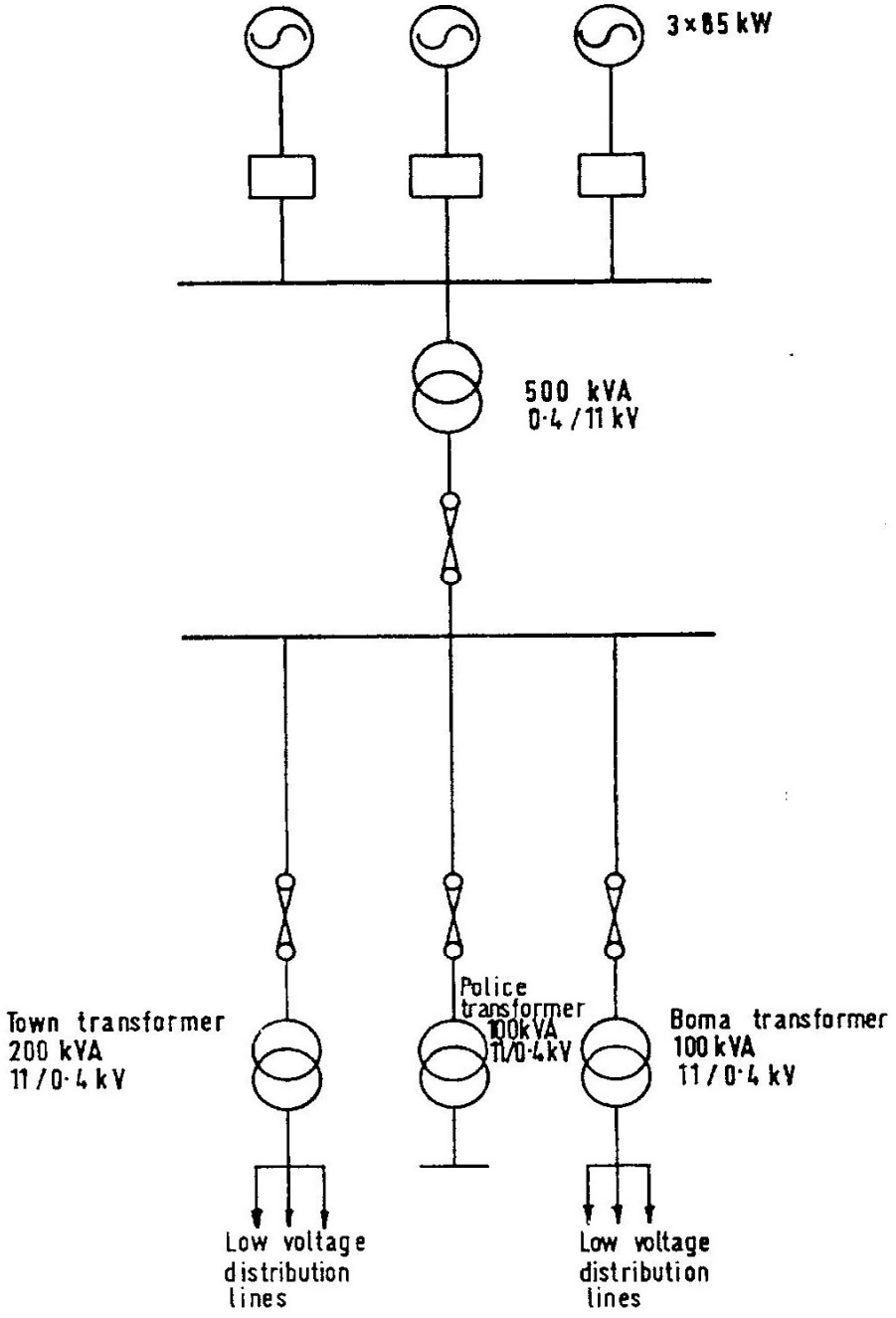

Figure 1: One line diagram of Urambo Township electrical power distribution system

tic consumers, use electricity for lighting only (a typical household has 4 bulbs). While the high income domestic consumers uses electricity for lighting (a typical household has 10 bulbs), and powering electrical appliances such as radio, television, video cassette recorder (VCR), electric cookers etc. Since all domestic users pay a flat rate of 5000.00 Tanzanian shillings per month, this caused a lot of complaints especially from low income consumers who also happen to be low energy users. They felt that they were subsidizing high energy users who are also high income earners. As a result some consumers have opted out of UECCO membership. Consequently as of June 1994 there were only 46 active UECCO members mainly from the high income earning group.

With the reduction of UECCO members the peak power demand has also decreased, therefore currently there is no power shedding being practised.

Table 1: Time of the day versus generated current in each phase

	Phase loads in Amperes											
Date	15/12/92			16/12/92			17/12/92			18/12/92		
Time (hours)	R	B	Y	R	B	Y	R	B	Y	R	B	Y
19.00	90	95	52	60	90	85	85	50	90	90	92	50
19.15	95	98	60	60	105	95	98	60	99	90	92	55
19.30	100	101	61	60	110	100	100	65	99	92	95	55
19.45	100	102	61	65	115	105	109	60	109	95	95	58
20.00	105	109	60	70	119	109	110	60	102	97	100	60
20.15	105	110	60	70	115	105	109	65	105	98	105	60
20.30	105	110	61	70	115	100	110	69	100	100	108	60
20.45	105	111	60	65	110	100	105	62	102	100	110	60
21.00	106	112	60	65	110	100	105	62	100	100	112	60
21.15	107	110	60	66	109	100	100	60	100	100	115	60
21.30	105	110	60	66	109	100	105	60	100	100	112	60
21.45	104	109	60	70	109	98	102	61	100	100	111	61
22.00	103	107	59	61	101	95	100	60	100	100	110	59
22.15	100	105	60	60	101	94	99	60	98	99	105	58
22.30	95	103	55	60	101	91	98	55	98	98	102	55
22.45	93	100	54	60	98	90	98	55	98	95	98	55
23.00	90	95	52	60	90	89	95	55	93	90	95	50

Effect of Phase Imbalance on Fuel Consumption

Generator fuel consumption data when load shedding was being practised that is, fuel consumption with phase imbalance was compared with generator fuel consumption when there was no load shedding that is, with phase balanced (see table 2). There is a clear evidence that fuel consumption with phase imbalance is 25% more than the fuel consumption with phase balanced.

Table 2. Comparison of fuel consumption with and without PHASE BALANCE

Date	16/12/92 with phase imbalance	24/6/94 with phase balanced
Energy generated in kWh	245	245
Fuel consumption in litres	100	80
Duration in minutes	240	240
Specific fuel consumption in litres/KWh	0.41	0.33

Effect of the Use of Efficient Bulbs to Reduce Load Shedding

The peak demand of Urambo district township is likely to surpass the available generating capacity in the very near future even after all three generators are put into operation. To find out how energy efficient bulbs can reduce energy consumption measurements were made in Mr. Hamad Hamud's house the Chairman of UECCO. He agreed to use electricity for lighting only during the test period. His house had 11 tungsten filament bulbs ranging from 60 to 200 Watts. Energy consumed by tungsten filament bulbs for three days was recorded, and then energy consumed by efficient bulbs for three other days was also recorded (see table 3). During the experimental period all bulbs were kept on from 7.00 p.m. to 11.00 p.m. every day. Tungsten bulbs rated above 60 Watts were replaced by 60 Watts tungsten bulbs.

Efficient bulbs are rated at 22 Watts and they give out same light luminance as a 60 Watts tungsten bulbs.

Table 3. Comparison on tungsten bulbs to efficient bulbs

Date	8-10 July 1994	11-13 July, 1994
Time of bulb used	Tungsten	Efficient
Time in hours bulbs were on	12	12
Energy consumed by the bulbs in kWh	8.7	3.2

NB: On each day generators are switched on at 7.00 p.m. and switched off at 11.00 p.m. The comparison was done between 11 x 60 Watts tungsten bulbs and 11 x 22 Watts Phillips efficient bulbs.

From table 3, the energy consumed by the Phillips efficient bulbs is 37% of energy consumed by tungsten filament bulbs. Lighting accounts for about 80% of the total power consumed in Urambo township [1], therefore if all customers were to switch from tungsten filament bulbs to Phillips efficient bulbs (or equivalent) the peak demand could be reduced by 51%. With power consumption reduces, the current is also reduced, consequently the power losses ($P_r = I^2 R$) and the energy losses ($E = I^2 Rt$) in the distribution lines will be reduced considerably [2].

CONCLUSIONS

Power shedding by taking out one phase from the transformer causes phase imbalance resulting in higher fuel consumption by generator(s) for the same energy delivered. For the same power output fuel consumption with unbalanced phases is 125 % of the fuel consumption with phases balanced.

Efficient bulbs can reduce lighting power by 63 % and since 80 % of the power in Urambo township is used for lighting, its peak demand could substantially be reduced by efficient bulbs.

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