GOOD PRACTICE CASE STUDY 001

SAVING ENERGY IN PUBLIC BUILDINGS: ELECTRICAL ENERGY SAVINGS IN A GOVERNMENT MINISTRY BUILDING (MINISTRY OF MINES & ENERGY)

The three storey Ministry of Mines & Energy Building in Accra

Summary

Recent electricity tariff adjustments and high incidents of electrical energy waste have been identified as some of the primary causes of high government recurrent expenditure. The managers of public buildings, whose utility bills are paid from state funds, are therefore looking for opportunities to reduce electricity costs.

Government Ministries, Departments and Agencies (MDAs) are making efforts aimed at reducing expenditure on utilities especially, electricity.

For this purpose, the Ministry of Mines & Energy (MOME) has since February 1998, undertaken measures, aimed at eliminating waste, improving efficiency and reducing electricity consumption in its building in Accra. The measures, which were very comprehensive, included:

a) Energy Auditing;

b) Educational Campaign among workers of the Ministry on Energy Efficiency & Conservation;

c) Power Factor Improvement;

d) Reduction in the number of lamps in the offices by 50%, and the replacement of 40W fluorescent lamps with Energy Efficient 36W fluorescent lamps;

e) Replacement of louver blade decorative windows with solid wood flush panels to reduce air leakage;

f) Relocation of window type air conditioners from the floor level to a height of 1.5-2m to allow for even and efficient cool air circulation;

g) Installation of Occupancy Sensors to **switch off** lights and air conditioners, when offices are not occupied;

h) Replacement of louver windows in the Conference Room with sliding aluminum frame windows.

These measures resulted in a reduction of electricity consumption in the building by 26,907kWh and maximum demand savings of 351kVA in 1999. The total cost saving in 1999 was ¢9.84million .The PIR sensors alone saved 14% of the total energy consumption or 21% of consumption due to air conditioning and internal lighting.

Introduction

Electricity supply in Ghana suffered a serious decline in 1998 as a result of several factors but mainly due to the poor inflows of water into the Volta basin, which until then accounted for 95% of Ghana's electricity supply. The shortage, which became known as the "power crisis", also coincided with a period when the Public Utilities Regulatory Commission (PURC) had initiated tariff adjustments aimed at removing price subsidies to enable the utilities meet the high cost of power production and distribution and also to attract private investments into the Power Sector.

The initial efforts at the MOME were aimed at reducing the impact of the power crisis and also to reduce expenditure on electricity, which skyrocketed, following the tariff adjustments.

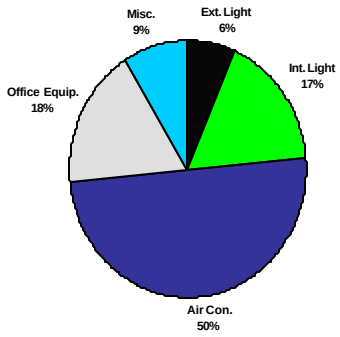
The Energy Audit

To establish the level of waste and to identify opportunities for its reduction, an energy audit was conducted at the MOME building by a team of local and international consultants and MOME staff led by NIFES Consulting Group of the UK. The audit, which was conducted in 1997, established the pattern of electricity use in the building, which is typical of other Government Ministry buildings. It also confirmed that about 30% of electricity cost could be saved if certain energy saving measures were taken.

Table 1. Electricity Consumption Pattern at MOME – 1997

Area	Annual Consumption, kWh	Percentage of Total, %
External lighting	15,240	6.4
Internal Lighting	40,660	17.1
Air conditioning	118,970	50.0
Office Equipment	42,070	17.7
Misc.	21,150	8.8
TOTAL	**238,090**	**100**

Fig. 1. Electricity Consumption Pattern, 1997



The measures that were recommended for implementation were categorized in terms of ease and cost of implementation and included the following:

No-Cost and Low Cost Measures

1. Management of Internal Lighting and Office Equipment: Steps were taken to ensure that PCs, lights, Air conditioners and photocopiers were **not** left "on" continuously during the day when the equipment were **not** in use or the rooms were **not occupied**.

2. Defrosting of Refrigerators. Refrigerators were de-frosted regularly.

3.Reduction in the number of fluorescent tubes by 50% and the replacement of 40W, 38mm diameter tubes with 36Watt energy efficient 26mm diameter tubes.

4.Repair/replacement of faulty photocell on a 400W security light

High Cost Measures

1.Installation of capacitor banks to improve power factor from 0.80 to 0.96.

2.Installation of PIR sensors to control Air conditioners and internal lights.

3.Improvement in Building Fabric.

ENERGY SAVING MEASURES

The following Energy Saving measures were undertaken:

1.Education:

The Ministry organised workshops for its staff and managers of other government ministries to educate them on simple but effective housekeeping measures that can be implemented to eliminate waste and reduce electricity consumption. The participants were educated on measures such as switching off lights, air conditioners and office equipment when leaving offices for long periods or when the equipment is not in use. Other energy savings tips included drawing of curtains to avoid direct sun rays into air conditioned rooms and firm closing of windows and doors to air conditioned rooms, as well as regular defrosting of refrigerators.

Lighting

Fifty percent of the lamps, in the 144 twin fluorescent lamp fittings in the offices were removed since it was established after experimenting for 12 months, that two lamps were enough to provide the needed level of illumination for office tasks instead of the 4 that were installed in each of the 72 offices. The tubes were also cleaned to improve the illumination levels in the offices.

The result of this exercise was a reduction in the lighting load by 5.76kW. Together with another eighty-one single tube fittings, all the 40W standard-38mm diameter fluorescent lamps were replaced with energy efficient 26mm diameter 36W tubes. This resulted in a further demand saving of 1.452kW. Thus the entire measures on lighting resulted in a demand saving of 7.212kW and an energy saving of 15,577kWh per annum. The demand savings at a power factor of 0.8 as was prevailing at the time translates into a kVA saving of 9kVA per month or 108kVA per annum costing ¢1,188,000. The energy cost savings is ¢3,118,515 per annum. The MOME spent a total of ¢700,000 on the lighting retrofits, resulting in a simple payback period of 2 months.

Power Factor Improvement

A 100kVAR automatic capacitor bank was installed to improve power factor which was 0.8 at the time to 0.96. Although the maximum demand of the building at the time was only 90kVA, this action reduced it further to 80kVA, allowing more air conditioners to be installed in 1998 without a significant increase in maximum demand. The total cost of purchase, installation and two year warranty was ¢5.5million cedis.

Capacitor Bank, installed at MOME

As a result of the power factor improvement exercise, the MOME building recorded maximum demand savings of 243kVA costing ¢2,673,000 in 1999. Power factor surcharges of about ¢1,780,524 was also avoided. The total cash saving for 1999, due to power factor improvement was ¢4,453,524.

External Lights

The MOME building has six 400W sodium lamps used for security lighting, which are switched on by photocells when it gets dark. A faulty photocell, which kept one of the lamps in the "on" position all the time was replaced at a cost of ¢55,000 resulting in the saving of 2,200kWh of electricity per annum. The cost saving amounts to ¢440,440, giving a simple payback period of 2 months.

Improvement in Building Fabric

Although the MOME building was designed with features such as east-west orientation, and

overhangs that reduce the impact of solar gain and therefore improves energy efficiency, single glazed louvred windows occupied about 55% of the total surface. This permitted high rates of air infiltration and ex-filtration, thereby contributing to high heat gains through ventilation. To reduce the high incidents of ventilation heat gains, all the lower level louvred windows were replaced with solid flush wooden panels, whilst the old louvre frames which did not allow for firm closure of windows were either repaired or replaced. The air conditioners were moved from the ground level to heights of 1.5-2meters above the floor level.

The lower louvred windows were replaced with solid flush wooden panels

This was done particularly to allow for even and easy circulation of cool air in the offices since cool air tends to fall as warm air rises. It was also done to prevent furniture and other objects from blocking the areas in front of air conditioner units, which could prevent or hamper air circulation. After this exercise it became possible to use one air conditioner instead of two in some of the large offices where two air conditioner units were installed since hot air infiltration was reduced to the minimum.

Air Conditioners were moved from the floor level to a height of 1.5-2meters.

Installation of PIR sensors to control air conditioners and internal lights

Seventy-two PIR sensors were installed in the offices to control lights and air conditioners for the following reasons:

a) About 50% of the electricity consumed in the MOME building is due to air conditioners. However it was discovered that in 20-30% of the time the air conditioners and lights were left "on" when the offices were not occupied, or even sometimes overnight.

b) Cleaners who prepare the offices in the mornings turn on the lights and air conditioners as early as 6.00am and leave them "on" when they have completed cleaning. These equipment run until officers begin to arrive after 8.00am.

c) Sometimes officers leave their offices for meetings or even lunch breaks and could proceed from there to other meetings or even home, leaving the air conditioners and lights running for long periods or even overnight.

d) The PIR sensors have the capability of turning off lights

and air conditioners when the room is not occupied for a predetermined period. They automatically switch them on when the room is re-occupied.

Passive Infra-Red Sensors to control lights and AC

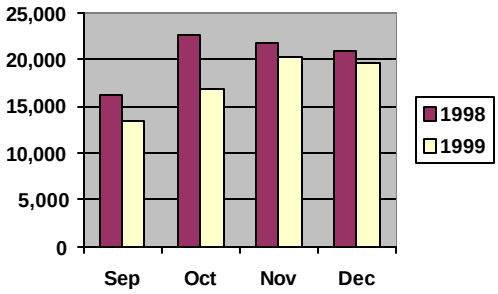
To ensure that air conditioner compressors had enough time to cool off before they are switched on again, special switching devices were incorporated in the air conditioner circuits, which allowed the units to be turned "on" if only the time elapsed from an earlier "off" event exceeds five minutes. This time was set to allow the refrigerant in the air conditioners to liquefy and settle before being switched "on" for the next time.

The installation of the PIR sensors started in August 1999 and was completed in September 1999. Energy cost savings achieved because of the measure as compared to the same period in 1998 are as indicated in table 1. The savings were 2,770kWh (17%) in September, 5,710kWh (25%) in October, 1,480kWh (7%) in November and 1,370kWh (7%) in December. The same period in 1998 has been chosen for comparison because the use of air conditioners, to a large extent depends on the weather, which also varies with the months. The months of November and December are among the hottest months of the year when air conditioners are used intensively. The energy savings over 4 months of the installation of the sensors were 14% of the total consumption in the building. This represents 21% of the air conditioning and lighting load.

Month	Monthly Consumption, kWh		Saving (1998-1999)	%
	1998	1999		
Sep	16,210	13,440	2,770	17
Oct	22,590	16,880	5,710	25
Nov	21,790	20,310	1,480	7
Dec	21,000	19,630	1,370	7
TOTAL	**81,590**	**70,260**	**11,300**	**14**

The total energy savings during the months of September to December 1999 was 11,330kWh, costing ¢2,268,267.

Energy, kWh consumption in 1998 and 1999



Summary of Savings for 1999

Measure	MD Saving, kVA	Energy Savings kWh	Cost savings, ¢
Capacitor Installat'n	243	-	1,780,534* 2,673,000
Lighting Retrofit	108	15,577	3,118,515
PIR Sensors	-	11,330	2,268,267
TOTAL	**351**	**26,907**	**9,840,316**

Power factor surcharge avoided because of improvement in power factor from 0.8 to 0.96.

The sensors saved 11,330kWh in 4 months. It is estimated that annual savings could be three times the reported figures.All cost savings include 10% VAT and government levies bringing the total avoided cost per kWh to ¢200.20 per kWh. This includes street lighting levy @¢0.5/kWh and National Electrification levy 1.7/kWh)

Hon. Abingya, Simon A., Deputy Minister for Mines & Energy- He allowed his office to be used for a 12-month trial before the sensors were installed in all the offices.

Hon. Dr. John Abu. Minister for Mines & Energy

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