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Investigating Electricity Cost Savings in Igbinedion University Campuses

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ABSTRACT

An investigative study was carried out on the I.U.O Campuses and it identifies the possible areas of energy wastage during peak and off peak periods. This paper discuses the importance of promoting attitudinal change in energy savings and consumptions.

The paper identifies possible areas in the campuses where existing equipments and accessories could be replaced by more energy efficient ones with the attendant long, medium, and short time cost benefit considered.

Finally the university management can improve service delivery (research, teaching, community development and services) using energy efficient devices/systems, reduce consumption and expenditure, while enhancing levels of service and comfort within the university community and environs.

1. INTRODUCTION

Over the past 30 years, the story of energy conservation and unwanted emissions has emerged as crucial to the world's experience of energy issues.

Energy services can provide cross-cutting influences on both social and economic development, thereby influencing a nation's ability to achieve Millennium Development Goals (MDGs). The use of commercial and industrial energy possibilities to create a friendly learning environment from the primary education to the University level of education is among the MDGs.

Access to affordable energy services is fundamental to human activities, development and economic growth. More than two billion people cannot access clean energy services, based on efficient use of gaseous and liquid fuels, and electricity. Without access to modern energy, the opportunities for economic development and improved living standards are constrained.

There are wide disparities in access to affordable commercial energy and energy services in both urban and rural areas. This inequity runs counter to the concept of human development, and threatens social stability.

The IUO campus is divided into three, the Main Campus (MC), the Teaching Hospital Complex (HC) and the Crown Estate (CE). The Crown Estate account, for approximately 82% of the electricity consumption in IUO. The consumption of electrical energy at the university is mainly categorised into two major areas: those used within the Main Campus (MC) for academic purposes ,i.e., for office lightings, air conditioning and ventilations, space heating, Computer labs, Printing, photocopying, fax and other electronic services, Motors for pumping water, and training laboratories; e.t.c, those used in the Teaching Hospital Complex for medical equipment ,office lighting, students training labs ,hospital ward lightings, staff and medical students accommodation and other hospital utilities, and Finally, those used in residences like students hostels/ residence and staff residence, Here energy is used for cooking and processing food, home comfort and luxuries , Ironing, lighting, laundry among others. In the Teaching Hospital (HC) alone there are about 390 ceiling fans and approximately 1658, 60W incandescent lamps. This kind of load and its profile shows that, there is extensive electrical energy consumption at the university campuses. The analysis at the end of this work shows that the energy used can be minimized through the use of energy efficient equipment, behavioural changes and energy management software. It is well known that there is an all round energy crisis all over the world and efforts are being made to conserve energy during the stages of conversion, transmission and distribution and at end use equipment.

Primary energy demand can be reduced substantially, while maintaining a given integrity level of energy services, through higher end use efficiency equipments and tools, consumer behaviour and energy management tools. The survey conducted in **Igbinedion University Campuses** shows that, there is a critical misuse (mismanagement) of energy supplied at all levels/cadre. This is caused by the fact that, the energy management concept is absent, researches on energy management and management of utility bills is low keyed, some few seminars/campaigns on energy costs/crisis and many people are unaware of the issue of energy management especially electrical energy. Investigating Electricity Cost Savings in Igbinedion University Campuses is another way that will provide for energy management and some relief to the Nigerian power supply company (PHCN) as well as provide monetary savings/benefits to the university by minimizing the amount of used electrical energy.

2. ENERGY OVERVIEW AND POWER SUPPLY INDUSTRY

The provision of efficient, reliable and affordable energy that is sustainable and environmentally friendly is the main objective in the government's energy policy framework. Regarding the electricity sector, the core problems and objectives of any Government remain the following:

- Increase in generating capacity that is presently inadequate and unable to meet the demand
- Increase in capital investment to improve the poor state of the transmission and distribution system which results in high technical losses and unmetered consumption
- Improving efficiencies so as to reduce the extremely high cost of energy generation

The Government continues to undertake measures at overcoming these problems through institutional strengthening and other restructuring efforts. In that regard, the Government welcomes local and foreign interest in the sector so as to achieve the short to medium term, the following:

- Reduce the cost of electricity
- Increase the accessibility and supply reliability of electricity nationwide, and
- Mitigate the environmental impact of the power sector

Putting into consideration

- Industrial and commercial power supplies must be reliable.
- Power supplies must cater for a variety of input supply voltages and improved quality supply.

The share of electricity consumption in the commercial sector is 27 %(2308KW/hr). [1] The average cost of one unit of electricity is ₦ 6.75 (US 5 cent) and the bill for IOU is estimated at ₦ 5.2 million (US $38,519) annually. Some of the energy intensive electrical gadgets used in this university are ovens/ microwaves, fridges, electronic appliances, air-conditioners, refrigerators, water pumps, hospital equipments. Most of them are low energy efficient standard gadgets and they consume more energy as compared to efficient standard gadgets; thus they prove to be costlier in the long run. Consideration should be given to the "life cycle cost" rather than the capital cost while purchasing any gadget.

Table 1: Electricity Tariffs In Nigeria.

S/n	Category	Amount (kW-hr)	Amount (kW-hr)
1	Residential with single phase meter	₦ 4.00	3US cent
2	Residential with 3-phase meter	₦ 6.50	4.8UScent
3	Commercial with single-phase meter	₦ 8.00	6US cent
4	Commercial with 3-phase meter	₦ 8.50	6.3UScent
	Average	**₦ 6.75**	**5US cent**

Exchange rate used: USD$1 = ₦135:00.
Source: *NEPA* (The energy corporation of Nigeria now PHCN). [2]

3. ENERGY SITUATION AND CONSUMPTION IN IUO CAMPUSES

Electrical energy used in the IOU Campus is for the provision of services such as lighting, ventilation, water heating, refrigeration, powering office equipment, commercial usage, teaching hospital equipments, banking services and other uses such as community development programmes. The amount of energy used to provide these services depends on the activities taking place in the campuses; for example, health care, offices, eateries, banks, Class rooms and lecture theatres and so on. EIA classifies commercial buildings by the activity occupying the most floor space in the building. This classification is based on the premise that buildings within the same principal building activity have similar energy consumption patterns and that activity classification is useful to examine differences in energy use among various types of buildings.
The amount of energy used as per number of activities can be referred as energy intensity indicator.

Energy efficiency is a vital part of the nation's energy strategy, and has been, since the first oil crisis in 1973. As part of a national priority for improving energy efficiency, the Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) established a new national system of indicators to track changes in the energy intensity of our economy and economic sectors over time. This system of energy intensity indicators can:

- show how the intensity of energy use and its components are changing
- help raise public awareness about how and why energy intensity has changed over the years
- compliment other provided inputs to policy and program analyses, including improved understanding of the impact of program and policy choices on energy intensity, such as supplementing energy demand forecasting or assessments of a program's influence on energy intensity changes

- improve understanding of the role of efficiency improvements in our changing energy markets

Energy-intensity indicators are used to measure the ratio of energy consumption to the demand for services using the demand indicators. The energy intensity indicators may be applied across the entire sector, or conditionally for a specific end use, or other limiting characteristics. A commonly used energy-intensity indicator for the commercial building sector is energy consumption per square foot.
IUO campuses is divided into three namely the Crown Estate (CE), Main Campus (MC), and the Teaching Hospital Complex (HC).

Crown Estate (ES):
The Crown Estate consumes an estimated 82% of the total energy consumption of IUO for PHCN's supply. This amounts to an estimated figure of ₦4.8million (US $35,556) per annum. The Estate is mainly residential and it accommodates all students and about 90% of the staff in various hostels and housing units varying from 1 bedroom, 2bedroom to 3bedroom chalets, duplexes, and so on. Lighting consumes the bulk of energy needs in the estate with an estimated 10800, 60watt incandescent lamps. There are other activities in the estate whose average energy consumption cannot however be accounted for. This includes small scale business vendors in the estate, telephone operators, and places of worship (fellowships, churches, mosques) which hold regular services with various electronic gadgets. IUO is billed using the maximum demand meter at ₦5.0 (US 3.7cent) KW/hr. The estate is usually powered at night for at least 3hours by a 1650kWA generator when PHCN's electricity is not available. The cost of running the generator annually is ₦16.25million (US $120,370). The energy consumption of crown estate decreases as the university community all take off for the main campus and hospital complex.

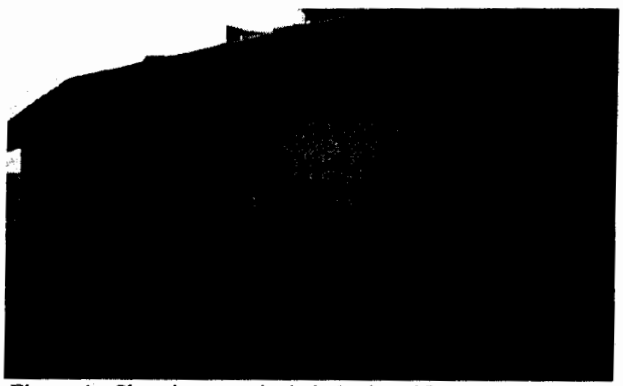

Figure 1: Showing a typical chalet in IUO crown estate.

Table 2: Summary of Energy Situation In IUO Crown Estate

S/N	BUILDING/HOSTEL	TOTAL NUMBER OF A PARTICULAR TYPE OF BUILDING	FAN (100W)	BULBS (60W)	FRIDGE	AC (1.7KW)
1	BOYS HOSTELS	1,340	1,200	5000	970	N/A
2	OLD GIRLS HOSTEL	128	256	1,150	56	N/A
3	NEW GIRLS HOSTEL	273	446	1723	220	N/A
4	1 B/D ROOM STAFF CHALETS	5	10	60	3	10
5	2 B/D ROOM STAFF CHALETS	5	15	95	4	15
6	3 B/D ROOM STAFF CHALETS	90	360	2,100	75	340
7	DUPLEX (P-BLOCK)	10	60	265	8	55
8	GUEST HOUSE	54	NIL	370	49	54
9	BUSINESS VENDORS, STAFF CLUB	-	8	50	N/A	16
		TOTALS	2,355	10,813	1,385	490

SOLAR STREET LIGHT = 60
NORMAL STREET LIGHT = 180
NOTE (N/A Means the Data was Not Available at Time of Investigation)

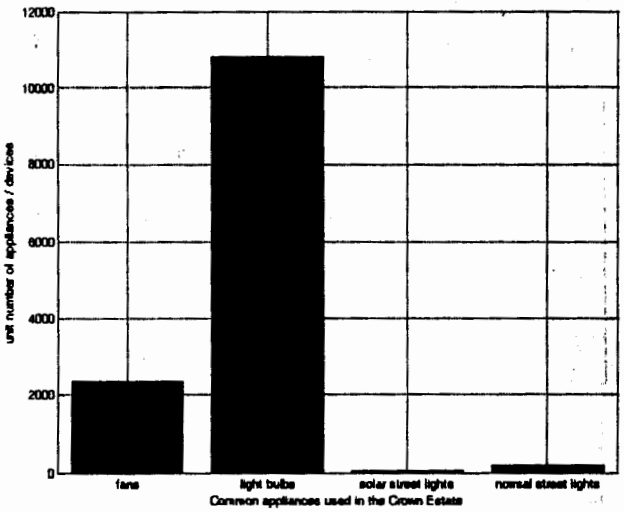

Figure 2: Showing the common appliances used in the Crown Estate.

Main Campus (MC):
The Main Campus is strictly an academic environment; it houses the Colleges of Engineering, Natural and Applied Sciences, Law, Arts and social sciences, Business and Management studies respectively and the Central Administration building. No other activity takes place in the MC after close of work until the next day. The main campus accounts for just 4.5% of PHCN electricity supply cost which is averagely about ₦98,000 (US $726) per annum.

Electricity used in the MC is basically for office equipments like computers, fax, printers, fans, air conditioners, photocopiers, and rarely office lighting, since it usually opens only within working hours. However the Gen. Abdusalami A. Abubakar College of Engineering for example houses some machines that consume heavy power but since they are rarely used, their consumption is not as significant as that of the office

equipments which are usually powered on, all through the working-hour periods.

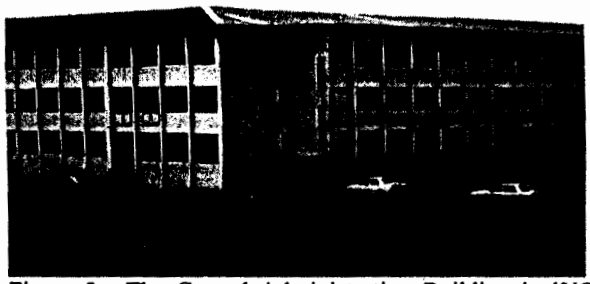

Figure 3: The Central Administration Building in IUO main campus.

The MC is usually powered by a 250kVA generator when PHCN's electricity is not available; thus the MC is usually powered using the generator for 3 hours of all working days. This amount to ₦1.5 million (US $11,111) the generator is supported by a 500kVA type in the college of Law but it used on rare occasions.

Table 3: Summary of energy situation in IUO Main Campus.

S/N	BUILDING / HOSTEL	FAN (100W)	LAMPS (60W)	FRIDGE	AC (1.7KW)
1	ENGINEERING BLOCK	58	110	4	5
2	NATURAL SCIENCES	30	90	N/A	4
3	LAW	177	215	N/A	3 10 (5KW)
4	CENTRAL ADMIN	90	160	N/A	36
	TOTAL	355	575	48 (1,7KW)	10 (5KW)

SOLAR STREET LIGHT = 13
NORMAL STREET LIGHT = 6
NOTE (N/A Means the Data was Not Available at Time of Investigation)

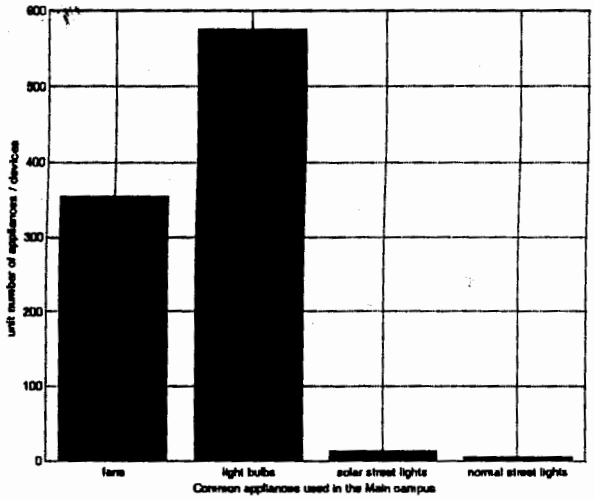

Figure 4: Showing the common appliances used in the Main Campus.

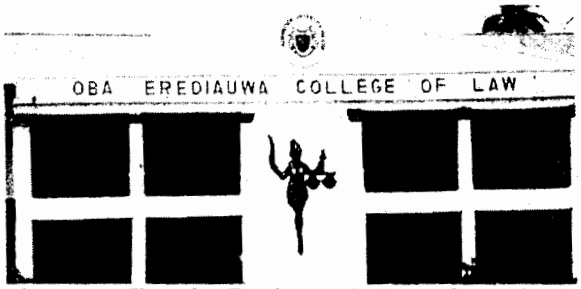

Figure 5: The Oba Erediauwa College of Law in IUO main campus.

Hospital Complex (HC):

The HC houses the teaching hospital complex, classrooms, staff offices, laboratories, staff and medical student's hostels, the university mosque and chapel, e.t.c The energy consumption average 13.75% of IUO total energy consumption and is estimated at ₦302,000 per annum (US $2,237). Electricity used in the **HC** is basically for office equipments, air conditioners, fans, photocopiers, hospital equipments, powering laboratory equipments, lighting the wards, and other domestic luxuries for the few residences there. The teaching hospital complex has a 500kVA generator and 4 other 5kVA generators for the medical, paediatrics, emergency ward and laboratory respectively. ₦640,000 (US $4,740) is spent annually to fuel the generators for a minimum of 3hours a week. The table below summarises the energy situation in the Hospital Complex.

Table 4: Summary of energy situation in IUO Hospital Complex.

S/N	BUILDING/ HOSTEL	FAN (100W)	LAMPS (60W)	FRIDGE	AC
1	COMPLEX	290	954	N/A	N/A
2	RESIDENCE	100	704	N/A	N/A
	TOTAL	390	1,658		

SOLAR STREET LIGHT = 2
NORMAL STREET LIGHT = 79
NOTE (N/A Means the Data was Not Available at Time of Investigation)

4. METHODS AND RESULTS OF THE INVESTIGATION

Careful surveys were carried out in all the various sites of the IUO campuses including the Crown Estate. This helped in physically obtaining the data highlighted on tables 2, 3& 4, and an approximate energy situation of the campuses, and with that knowledge, we recommend methods of reducing energy consumption by eliminating irresponsible energy use, one of which we discover is by putting office and home appliances on stand-by mode.
A small survey was carried out which confirms that nearly 80% of both staff and students prefer to put their appliances on stand-by rather than switching them off or unplugging them from the wall.

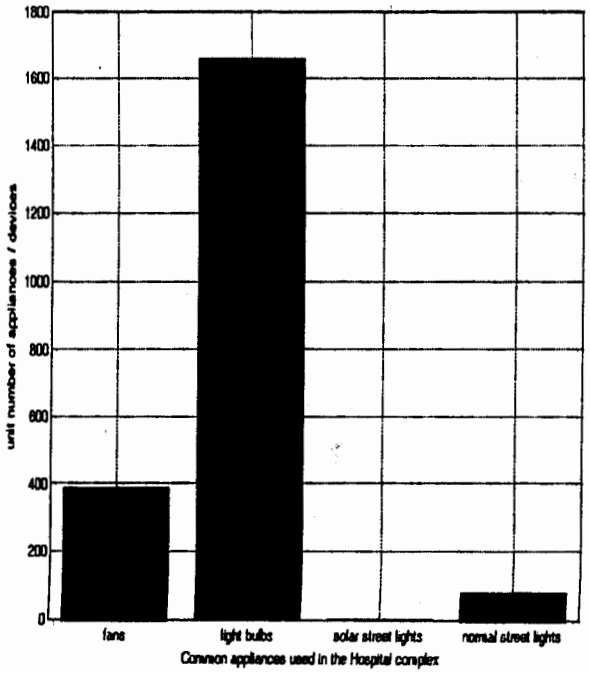

Figure 6: Showing the common appliances used in the Hospital complex.

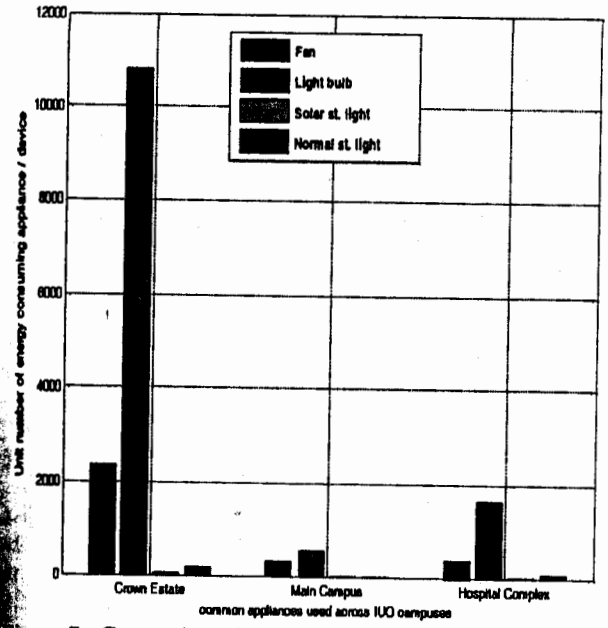

Figure 7: Comparing The Total Unit Of Appliances Used On The Three Campuses.

Table 5: Table Showing Amount Of Power (In Watts) Drawn By A Few Common Household Appliances.

S/N	APPLIANCE/ DESCRIPTION	WATTS	DAILY HOURS	ANNUAL COST (₦)	WATTS	DAILY HOURS	ANNUAL COST (₦)
1	SMALL TV (14" SCREEN)	44	6	65	13	18	576
2	SMALL TV (28" SCREEN)	80	60	1183	7	18	310
3	VCR 1	13	6	192	11	18	488
4	DVD PLAYER	12	6	177	3	18	133
5	MINI TOWER HIFI SET	27	3	200	12	21	621
6	COMPACT CD/ CASSETTE PLAYER	7	2	35	2	22	106
7	100 WATT BULB (OLD)	100	10	2464	<< << << NO STAND-BY MODE		
8	100 WATT BULB (LOWER ENERGY)	20	10	493			
9	WASHING MACHINE	1000	1	2464	11	23	623
10	COMPUTER	55	6	813	3	18	133
11	LCD FLAT SCREEN	42	6	621	2	18	89
12	COMPUTER PRINTER	8	1	20	2	23	113
TOTAL COST				₦9312			₦3194

Culled from: www.goingcarbonneutral.co.uk/energy 11/02/2008.[3]

From the investigation the total amount IUO is spending on providing electricity is ₦23.5million (US $174,740) annually out of which 78% is spent on fueling the various generators alone not to mention the cost of their maintenance. The management is thus advised to seek other sources of Renewable energy to complement the generators.

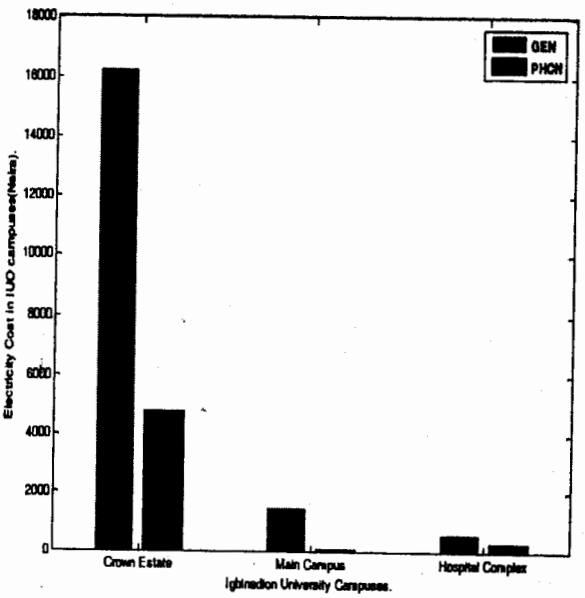

Figure 8: Annual Cost of Electricity in IUO Campuses.

From the table, we concluded that turning appliances off at the wall when not in use stops electricity from being needlessly wasted, and saves money. (See table5 above). Some items can use more power each day on stand-by than when in use.

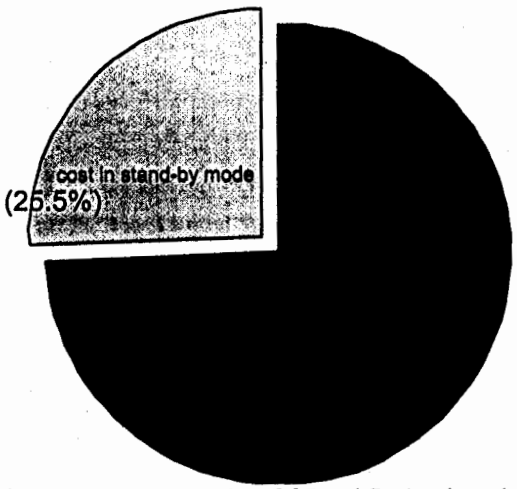

Figure 9: Percentage Cost Of Stand-By Mode and In-Use Mode.

The university can save a lot of energy and electricity bill by replacing all the normal (electrically powered) street lights with solar ones. This can be a lot costly in the short term but it will save more money in the long run since the street lights are expected to be on for at least 12 hours daily and the country is exposed to a high solar radiation level with an annual average of 3.5 – 7.0kWh/m^2/day. [3] This will save the university a considerable amount of money, against the backdrop of the energy consumption of 180 street lights in crown estate for instance, especially when on generator supply and considering the cost of fuel in the country. It is recommended however that the existing solar lights be renovated, because most of the already installed ones are not working.

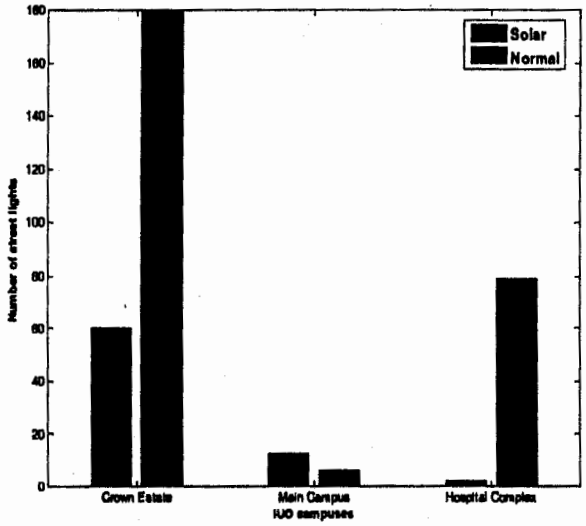

Figure 10: Number of Normal and Solar Street Lights in IUO Campuses

The greatest potential for energy savings in IUO campuses is in the lighting, especially lights that are used for long periods of time. Therefore savings were calculated for those lights that will be lit for 5 hours per day. We however assume that compact fluorescent lights (CFL) need about one-third of the wattage of incandescent lights (which is widely used in IUO), although an 18-watt CFL produces the same number of lumens as a 75-watt incandescent.

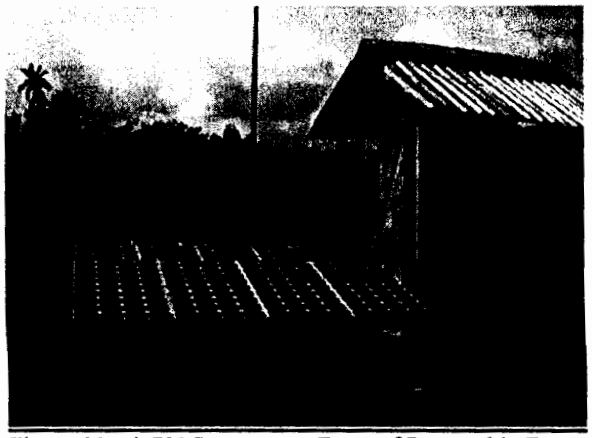

Figure 11: A PV System as a Form of Renewable Energy Source at the College Of Engineering, IUO.

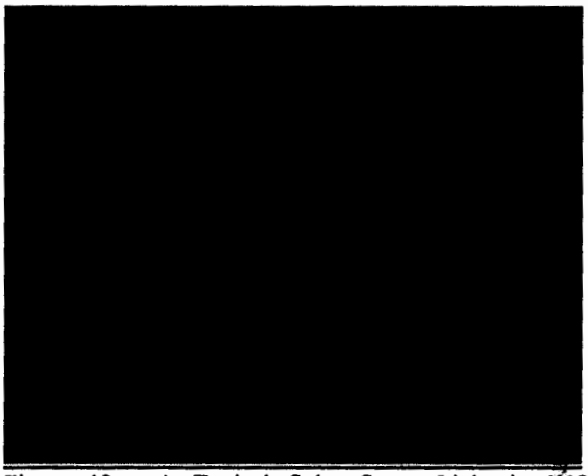

Figure 12: A Typical Solar Street Light in IUO Campuses.

From our investigation of the 6,000, 60watts incandescent lights used for more than five hours per day, IUO will spend ₦1800 per hour while for the same number of 18watts CFL will cost IUO ₦540 per hour. If it takes an extra ₦250 to replace a 60 watt incandescent light with an 18watt CFL, the university should have spent about ₦1.5million. This is quite a sum to invest in replacing bulbs but with the long operational life of (3,000-10,000 hours) of the CFL and the fact that the university will save averagely ₦1,260 per hour, the cost of replacement will be saved, at most, in 60days, and more energy and

money will be saved annually for a very long period, and our environment will also be better.

Figure 13: A normal Street Light in IUO campuses.

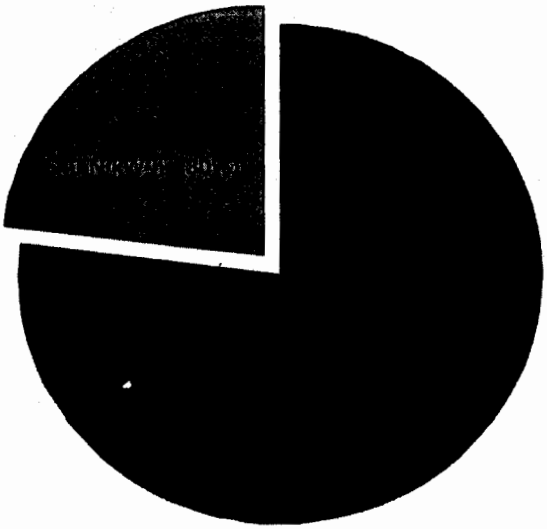

Figure 14: Cost Savings For 6000, 60watts Incandescent Bulbs replaced with 18watt CFL in IUO.

5. RECOMMENDATIONS

Several areas have been identified where considerable energy can be conserved. Such areas with specific actions and attitudinal change that will lead to eventual energy efficiency are, being recommended for IUO management. Some of the actions could have high cost implications in the short term, but lots of energy and utility bills will be saved in the long term.

Thermal Efficiency Strategies

- The country is exposed to a high solar radiation level with an annual average of 3.5 – 7.0kWh/m^2/day, so solar energy alternatives should be incorporated more and the existing ones should be renovated.

Lighting Efficiency Measures

- Replace incandescent lamps with fluorescents.
- Replace standard fluorescents with higher efficiency fluorescents.
- Replace exterior incandescent and halogen lighting with high pressure sodium.
- Install controls to reduce operating time of lighting.
- For outside lighting, install a motion sensor that turns the lights on automatically when somebody walks up, and turns the lights off automatically after 1-5 minutes.
- Use lighting control systems such as occupancy sensors, timers and dimmers.
- For any light that should be on all night (e.g., stairways), replace the bulbs with the lowest wattage bulbs as appropriate.
- All unnecessary light bulbs and appliances should be turned off.

Maintenance and repair improvements such as maintenance of existing solar street lights, etc.

Use Higher Efficiency Equipment

- Replace old appliances with new high efficiency units. For example, a typical old fridge consumes around 600 kWh/yr, while a high efficient fridge will consume only 160 kWh/yr. Light bulbs, refrigeration products, laundry are typical appliances for which efficiency can be improved.

Appliance and Office Equipment Efficiency Measures

- To maximize savings with a laptop, put the AC adapter on a power strip that can be turned off (or will turn off automatically); the transformer in the AC adapter draws power continuously, even when the laptop is not plugged into the adapter.
- All standby powered equipment should be turned off (TV sets, microwave oven, computer, fax machines, printers, and photocopy machines) at once when not in use.

Cooling and Refrigeration

- Reduced thermostat temperature by 1°*C* can cut heating bills by 7%.
- Use ceiling or table fan as first line of defense against summer heat.
- A good air conditioner will cool and dehumidify a room in about 30 minutes; so use a timer and leave the unit off for some time.
- Fridge doors should not be left open for longer than necessary (cold air escape). Hot or warm food should not be put straight into the fridge (needs to cool down first).
- The freezer should be regularly defrosted to keep it running efficiently. If it tends to frost up quickly, the door seal should be checked. And if the fridge is next to a cooker or boiler, a good gap should be left between them.

Use Solar Energy and Alternative Energy Options

- The country is exposed to a high solar radiation level with an annual average of 3.5 – 7.0kWh/m^2/day.
- Average cost of typical sources of renewable power for Mini hydro is ₦6.75-₦13.5 (5-10 US

cent); Solar PV: ₦27-₦54 (20-40 US cent); biomass power: ₦6.75-₦16 (5-12 US cent); wind power: ₦8-₦13.5 (6-10 US cent). [2]

Cooking and Washing

- Improve efficiency of cooking operations (for electric cooker make sure cookers are well covered)
- Washing machines and tumble dryers should always be used at full load or with the economy programme. The low temperature programme should always be used, washing powders are just as effective at lower temperatures.

6. CONCLUSION

It can be concluded that Electricity efficiency is the practice of decreasing the quantity of electricity used. It may be achieved through efficient energy use, in which case electricity use is decreased while achieving a similar outcome, or by reduced consumption of electrical services. This savings in IUO will result in

- Increase of financial capital as in reduction in electricity bill (see figure 9 and 14).
- Environmental value (EGH, global warming etc),
- National energy security,
- Personal security and human comfort.

Most of the common appliances used on the campuses are low-energy efficient standard gadgets, and they consume more energy as compared to efficient standard gadgets so they prove to be costlier on a long run.

- For instance replacing 6,000, 60watts incandescent lights used for more than five hours per day will save IUO ₦1,260 (US $9.3) per hour.

Consideration should therefore be given to the "life cycle cost" rather than the capital cost, while purchasing any gadget.

From this investigation we have discovered that following efficient practices and using energy efficient devices on the campuses can save at least about 20-30% of the annual energy cost (see figure 14).

Proper metering should be implemented for the staff quarters and business vendors in the Crown Estate which will provide real-time consumption information. This will allow a typical household to reduce electricity usage by 10 - 20% since seeing the actual usage that results from existing household habits will lead most people to change their attitude towards conservation and reduce overall consumption.

From figure 16 the average amount spent on providing electricity is ₦23.5million (US $174,740) annually. 78% of this is spent on fueling the various generators in the campuses not to mention other smaller generators belonging to departments and units.

The management should therefore seek alternative sources of energy urgently especially the 265 normal street light should be replaced with solar street light immediately (see figure 10).

If the management of the university empowers the product and energy centre with adequate resources, proper enlightenment programmes to forestall the irresponsible use of energy by the university community and an easy to follow guide for household can be developed such as energy saving tips. This will help to forestall attitudinal waste like keeping common household appliances in standby therefore incurring 25% of their annual energy cost (table 5and figure 9).

7. REFERENCES

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