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Towards Energy Efficiency - Zimbabwe Electricity Transmission and Distribution Company Compact Fluorescent Lamp Rollout Project: The Preliminary Survey

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Abstract*— *This paper focuses on the preliminary survey on the compact fluorescent lamp (CFL) rollout project that was done by the University of Zimbabwe in July 2012 on behalf of the Zimbabwe electricity transmission and distribution company (ZETDC) to establish the expected savings from the demand side management initiative. The major objective of the initiative was to reduce evening peak demand by 180Mw. Although Light emitting diodes (LEDs) are more efficient, ZETDC chose CFLS after considering their budget and payback period. A questionnaire survey was done to establish existing lighting used by households and the lighting behaviour of the different households. From this data, calculations for the energy consumption as well as expected consumption after the retrofit were done. Expected savings were also calculated from the survey data. From the preliminary survey, it was established that the power utility was going to save a minimum of 203Mw during the evening peak period.

***Index Terms*—Compact Fluorescent Lamps, Energy Management, Measurement & Verification, Rebound Effect.**

I. INTRODUCTION

Zimbabwe electricity transmission and distribution company (ZETDC) has embarked on an Efficient Lighting Initiative which will make substantial contribution towards energy savings to reduce the national demand. Under the initiative, Five million five hundred thousand compact fluorescent lamps (CFLs) will be distributed all over Zimbabwe to reduce the energy consumed by residential lighting. Large energy savings are expected to be achieved especially in the evening peak period. To quantify the savings, ZETDC has contracted the Faculty of Engineering, Centre for Continuing Engineering Education (CCEE) at the University of Zimbabwe to perform an independent measurement and verification exercise to quantify the energy savings arising from the project through measurement and verification (M&V).

CFLs use significantly less power than conventional incandescent bulbs. In Zimbabwe the majority of low-income households use less electricity per month since high energy consumption appliances (geysers and others) are often too expensive to purchase and use. Seemingly, much of the energy used in low-income households is for lighting and thus CFLs may reduce electricity bills and result in significant savings for them. Although lighting contributes a small percentage of ZETDC's load profile, replacing incandescent with CFLs can potentially reduce peak demand because it coincides with the time that energy is used for cooking, space heating and water heating and lighting is a component of peak demand that can easily be reduced using CFLs.

The main interest for all stakeholders is how much energy is being saved and are the savings being sustained. Some of the justifications for the focus on energy efficient lighting thus include the following observations [1]:

- ✓ Lighting consumes 8-17% of total electricity produced in industrialised countries and the share in developing countries can be larger.
- ✓ Lighting energy use can be reduced by as much as 75% without reducing lighting levels.
- ✓ Lamps have a relatively short life compared to other capital equipment and, therefore, savings can be quickly realised through an implementation program which capitalises on this high turnover rate

M&V is the process of using measurement to reliably determine the actual savings created by the project. The M&V process is designed to provide an impartial, credible, transparent and replicable quantification and assessment of project impacts, sustainability and savings that result from Demand Side Management (DSM) activities [2[-[5]. Savings are determined by comparing energy use before and after implementation of the project, making appropriate adjustments for changes in conditions that may affect the measurements. M&V activities include site surveys, metering of energy, monitoring of independent variable(s), calculation, and reporting. When adhering to International Performance Measurement and Verification Protocol's (IPMVP) recommendations [2], these M&V activities can produce verifiable savings reports. Energy savings measurement techniques will help ZETDC to:

- Accurately determine the energy savings of the CFL rollout program.

- Adjust the energy conservation measure design or operation to improve savings, achieve greater persistence of savings over time and lower variations in savings.
- Enhance the value of emission-reduction credits.
- Increase public understanding of energy management as a public policy tool.
- Increase transparency and credibility of reports on the outcome of the investment.
- Provide feedback for future project designs.

In order to help ZETDC achieve the above, the Faculty of Engineering (CCEE) will ensure that the basic fundamental principles of good M&V practice listed below are strictly adhered to.

- ✓ **Accuracy** – The M&V reports produced will be as accurate as the budget will allow. The budget however will not be more than 5% of the total project implementation costs. Accuracy tradeoffs will be accompanied by increased conservativeness in any estimates and judgments.
- ✓ **Complete** – The reporting of energy savings will consider all effects of the project. The M&V activities will use measurements to quantify the significant effects while estimating all others.
- ✓ **Conservative** – Where adjustments will be made of uncertain quantities, M&V procedures will be designed to underestimate the savings.
- ✓ **Consistent** – Reporting of the project's energy efficiency effectiveness will be consistent between:
    - ➢ Different types of energy efficiency projects
    - ➢ Different energy management professionals
    - ➢ Different periods of time for the same project
    - ➢ Energy efficient projects and new energy supply projects
    - ➢ Consistent does not mean identical since it is recognized that any empirically derived reports involve judgments which may not be made identically by all reporters.
- ✓ **Relevant** – The determination of savings will measure the performance parameters of concern, or well known while other less critical or predictable parameters will be estimated.
- ✓ **Transparent** – All M&V activities will be clearly and fully disclosed.

M&V activities involve the following:

- Pre-installation surveys
- Meter installation, calibration and maintenance
- Data gathering and screening
- Development of computational methods and acceptable estimates
- Computations with measured data
- Post-installation surveys
- Reports, quality assurance and Verification of reports by independent third party

Most of the M&V activities listed above overlap resulting in project synergies that require a well coordinated team effort by ZETDC, Energy Service Companies (ESCOs – contracted by ZETDC to replace the incandescent lamps) and the M&V team. This paper mainly focuses on the pre-installation survey that was done in July 2012.

II. OBJECTIVES

ZETDC's major objective is to reduce the evening peak demand by 180MW. In line with this objective, the M&V team's objectives will be to:

- Quantify savings through pre and post installation measurements of power consumption and time of use.
- Verify Energy Performance Annually.
- Track Post-Retrofit consumption and adjust Baseline for changes.
- Maximize Infrastructure by using Least-Cost M&V Option.
- Verify that lighting levels are not altered significantly during project implementation.

III. LITERATURE REVIEW

Although the best lighting technology being developed today is the Light emitting diodes (LED lighting technology, which consumes much less energy and lasts much longer than CFLs, with superior characteristics compared to other existing technologies, the decision to choose CFLs for the lighting retrofit was mainly based on costs, mainly focusing on the payback period. The payback period for CFLs is less than a year while that of LEDs can be several years. Based on the available budget and the need for urgent demand side management initiatives that would reduce load shedding in Zimbabwe, ZETDC decided to shelve LED technology lighting retrofit for the future when the cost of the bulbs go down to economic levels. The literature below compares the existing and the chosen retrofit technology.

A. Comparison of CFLs, Incandescent Lamps and Newer Technologies

Fluorescent and incandescent lights generally work in the same way: They excite certain types of atoms with energy until their electrons release photons of light. Mercury is a crucial part of how all fluorescent bulbs work, and replacing it is a daunting task. Still, manufacturers have cut back on how much they use. CFLs' mercury content dropped by at least 20 percent from 2007 to 2008. While the bulbs contained an average of 4 milligrams a few years ago, many now use as little as 0.4 mg.

By comparison, mercury thermometers contain about 500 mg of mercury, and older non-digital thermostats contain about 3,000 mg. **Table i** show the amount of mercury in different products in wide use to date.

Compact Fluorescent lights only release mercury when their glass breaks. Considering how often light bulbs are shattered.

Table i: Mercury Content in Different Products

Product	Amount of Mercury	Number of Equivalent CFLs
CFL	5 milligrams	1
Watch Battery	25 milligrams	5
Dental Amalgams	500milligrams	100
Home Thermometer	500milligrams to 2 grams	100-400
Float Switches in Sump Pumps	2 grams	400
Tilt Thermostat	3 grams	600
Electrical Tilt Switches & Relays	3.5 grams	700

Source: Literature from ZETDC

While changing them, and dividing that number by 10 (since a single CFL requires about that many fewer replacements), gives a negligible immediate risk of mercury exposure. While most fluorescent lamps finish their lives without shattering, however, it's another story once they're thrown out. They can easily break in trash cans, dumpsters or en route to a landfill. It's only a small amount of mercury, but it adds up as more and more people are buying them, and it also endangers sanitation workers who don't know they're carrying bags containing mercury vapour. Recycling programmes to collect them back from consumers must be put in place before their widespread usage.

The main downside with traditional incandescent bulbs is that they use only 10 percent of their energy to produce light, burning off the rest as heat. They waste 90 percent of the electricity that is mainly generated from coal and other fossil fuels justifying their ban by most governments to date. Despite the proven energy efficiency of CFLs, many people are still turned off by the light they emit, which is slightly bluer and flicker compared to the incandescent's warm, steady glow. A comparison of the two types of lamps is shown on **Table ii**.

A lot of research has been done on the safety of CFLs as replacement of incandescent lamps. Some of the major concerns came from St. Vincent's Hospital and the University of Edinburgh in terms of the health concerns of the CFL lamps [6]. The researchers did not come up with conclusive evidence.

B. CFL Retrofit Projects done Elsewhere

Table iii summarises some of the success stories in CFL retrofit projects. **Figure 1** shows the baseline and actual demand profile for the Kwazulu Natal project done in South Africa in 2007 [7]. This was caused by the replacement of 4.4 million lights. ZETDC is going to replace 5.5 million lights. If the given profiles below are a true reflection of what to expect, then the profile after the installation of the CFLs will be flatter than that one observed below.

Table ii: Comparison Chart of Incandescent lamps vs. CFLs

Characteristic		Incandescent Lamp	CFL
Life Span (Average)		1,200hours	8,000hurs
Watts of electricity used		60w	13-15w
Kilo-watts of electricity used		0.06kW	0.015kW
Contains toxic Mercury		No	Yes
Carbon dioxide emissions		Manufacturing less Carbon intensive	Manufacturing more Carbon intensive
Sensitivity to low temperatures		Moderate	Yes
Sensitivity to humidity		moderate	Yes
On/off cycling		Moderate	Yes – can reduce lifespan drastically
Turns on instantly		Yes	Takes time to warm up
Durability		Not very durable – glass and filament can break easily	Not very durable – glass can break easily
Heat emitted		Yes	No
Correlated Colour Temperature		2700 – 3300 K	2700 – 5000 K
Color Rendering Index		100	80-90
Lumens	450	40W	9-13W
	800	60W	13-15W
	1,100	75W	18-25W
	1,600	100W	30-55W

C. The Rebound Effect [12]

The rebound effect is a phrase which was originally defined to refer to the extent to which energy efficiency improvements are lost due to subsequent behavioural changes. Interestingly, the prevailing lack of understanding of rebound was equaled if not surpassed by the absence of suitable methods for quantifying it. In part, the lack is a consequence of the historical focus on the technical engineering of supply-side solutions to society's energy needs. It is no surprise therefore that the measurement of the extent to which some of these solutions fail has traditionally depended on techno-engineering methods, and therefore failed to adequately measure the effect.

A three year study was done at the University of Cape Town that culminated in a report that documented and quantified the rebound effect of energy efficiency initiatives in South Africa's residential sector, and to explore ways of mitigating that effect using awareness and education. The graph in

Figure 2 shows the impact on the load profile over time. The CFL exchange for this location took place in April to June 2006. Incandescent lamps were replaced with CFLs in a door-to-door project according to the Prince Albert study [12]. In total 52,392 incandescent were exchanged for CFLs, resulting in a maximum evening peak demand reduction of 3071 kW. The average impact between 18:00 and 20:00 on weekdays only based on analysis of the metered data was 465 kW. It is not possible to calculate exact figures for rebound using this graph as there are a number of confounding factors:

Table iii: CFL Retrofit Projects done in other Countries

Country& Area	Intervention	Year	Impact	Source
South Africa - eThekwini, - South Coast, - North Coast - Interior areas around KZN	4.4 million Incandescent lamps replaced with 14W and 20W CFLs	-October to December 2007	- Proposed savings was at least 135MW - Maximum evening peak demand reduction of 223.1MW	[7]
South Africa - Soweto -Daveyton	600 000 CFLs consisting of 14W and 11W units, were distributed and installed	November 2006	Average demand before the project roll-out in the Eskom peak period (18:00 - 20:00) was 35.2MW. For the same period the average demand after project roll-out was 6.88MW	[8]
Ghana	6 million incandescent replaced 6 million CFLs	October 2007	Peak savings of 124MW	[9],[10]
Poland -Chelmno (22,000) -Elk (54,000) -Zywiec (35,000)	Voluntary CFL Retrofit	Jan 1996	-15% - 16% peak demand savings recorded for target areas -No influence on voltage distortion from installing CFLs - Current distortion measurements not conclusive. - cost-effective investment	[11]

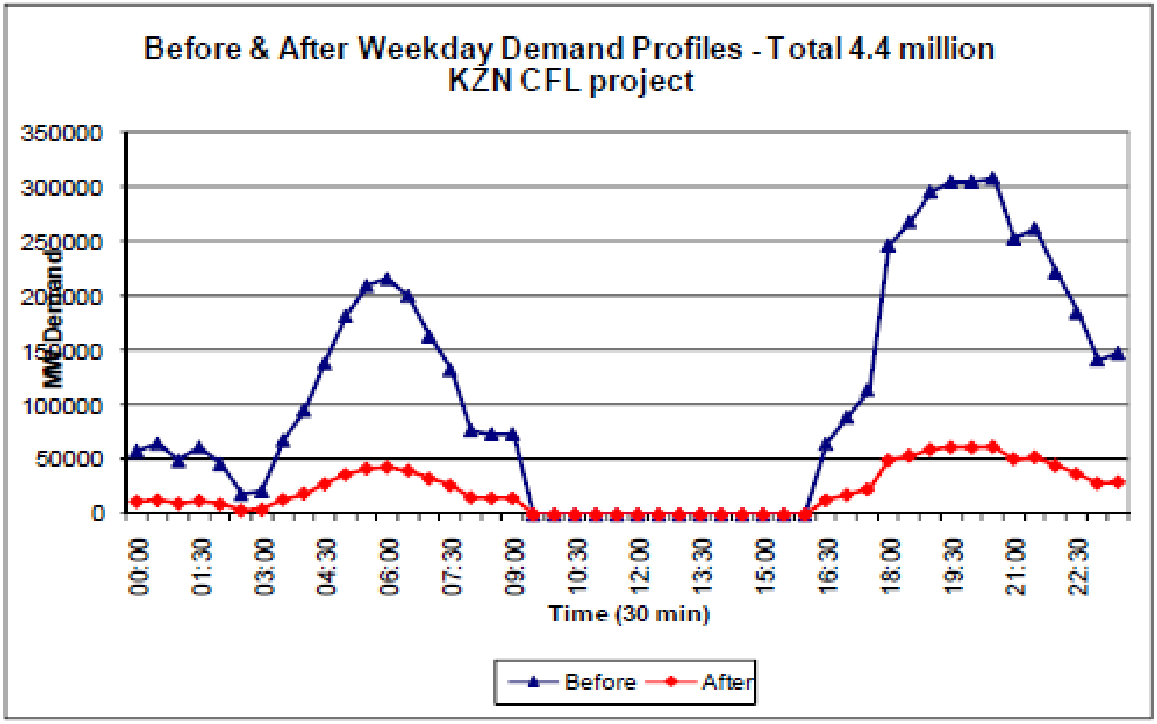

Fig 1: Average weekday operational demand profiles before and after project rollout of Kwazulu-Natal

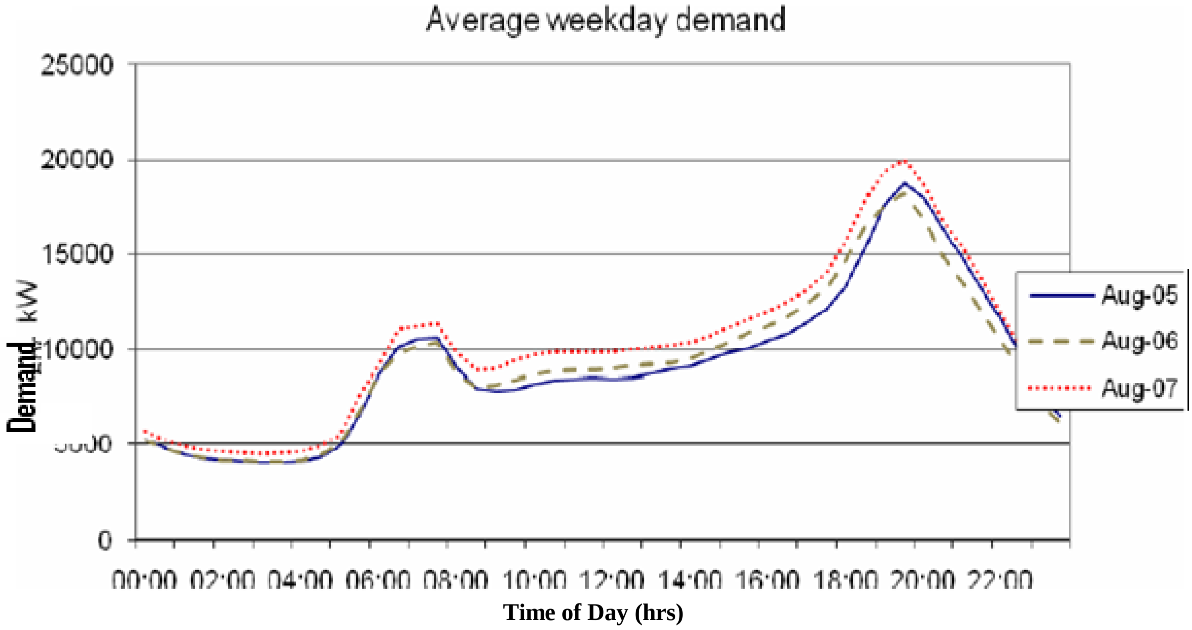

Fig 2: Delft CFL rollout showing the year-on-year shift in the load profile and possible rebound effects

- Increasing population size in the area.
- Inter-annual weather differences.
- Reversion to incandescent lights: the original CFLs had a cold blue light that was not well-received by consumers, and lifetimes were an average of 3 years.
- Other behavioural variation and indirect Rebound Effects.

This work illustrates the difficulty of extracting an exact number for direct rebound, indirect rebound, and other effects from load curve analysis. However, four empirical studies have concluded that the effect is between 5% and 12%. ZETDC has to embark on extensive education campaigns to minimize the impacts of the rebound effect.

D. Effect of voltage variations on the power consumption of CFLs [13]

Supply voltage variations have an impact on the power consumed by CFLs. Laboratory measurements were done by the University of Stellenbosch to determine the effects of supply voltage variations on the supply current and active power consumed by CFLs [14]. CFLs with different ratings were tested which included: 11W, 14W, 15W, 20W, 21W and 22W CFLs. The results obtained from the tests can be used to determine the actual power consumption of a specific rated CFL. Once the supply voltage profile is established, the actual power consumed by the CFLs can be derived from the results obtained. ZETDC is going to use 15w and 22w CFLs only. The results for these two light types are shown in **Figures 3 and 4** below. R^2 in the graph is the Coefficient of determination that indicates model's overall ability to account for variability in the dependent variable. Values are acceptable if R^2 is greater than 0.75. Lower R^2 values may indicate independent variables may be missing or additional data is needed. Once the supply voltage profile is known, the power consumed by the 15w CFL will be calculated from the equation:

$$y = 0.1561x + 12.045$$

Where: y = power consumption
x = Measured voltage

For the 22w CFL light, the equation would be:

$$y = 0.2486x + 16.928$$

From the ZETDC lamp specifications, the real power for the lamps must be above 85% of the rated power while the voltage will be allowed to fluctuate between 195V and 250V. These will be used in the calculation of the expected savings. Voltage variations affect all incandescent lamps. They have the effect of varying filament temperature which in turn increases or decreases lamp life. **Figure 5** below shows how electrical energy consumed vary with changes in supply voltage [15]. The incandescent lamp is basically a resistive device which is sensitive to voltage variation and its temperature changes significantly. This tends to work toward protection of the lamp as tests show that a 5% variation produces only 8% power variation but a 10% voltage change produces a change in power of approximately 16%. **Figure 6** shows how the lamp efficacy, life, light output and electrical energy consumed vary with changes in supply voltage. Graph shows that a 5 percent increase in voltage will decrease life by 50 percent; conversely a 5 percent decrease in voltage will increase lamp life by 200 percent.

E. Data Collation

More than 687,500 households were expected to benefit from the CFL distribution programme. This figure assumes that out of the total 5,5 million lamps planned nationally, 8 lamps would be installed per household. Each household would have a different lighting profile. To keep M&V costs at acceptable levels, it was proposed that residential areas be classified according to certain characteristics, and that operational profiles and typical lighting installed be determined for each classification. Households were Classified into a low, middle or high income group by examining the amount of rooms in the household or externally by observing the number of cars or garages in a household. The income classification is shown in **Table iv**. The income classification method enabled the M&V team members to quickly analyse the income group without interviewing all homeowners for the establishment of the expected savings. It is therefore important that a representative sample is selected to represent each income group. The minimum sample size required per class was determined from the equation as per IPMV recommendations [2]:

$$n = \frac{z^2 \cdot (C_v)^2}{(P)^2}$$

Where

Z = Z-statistic,

P = Precision required,

C_v= *coefficient of variation*

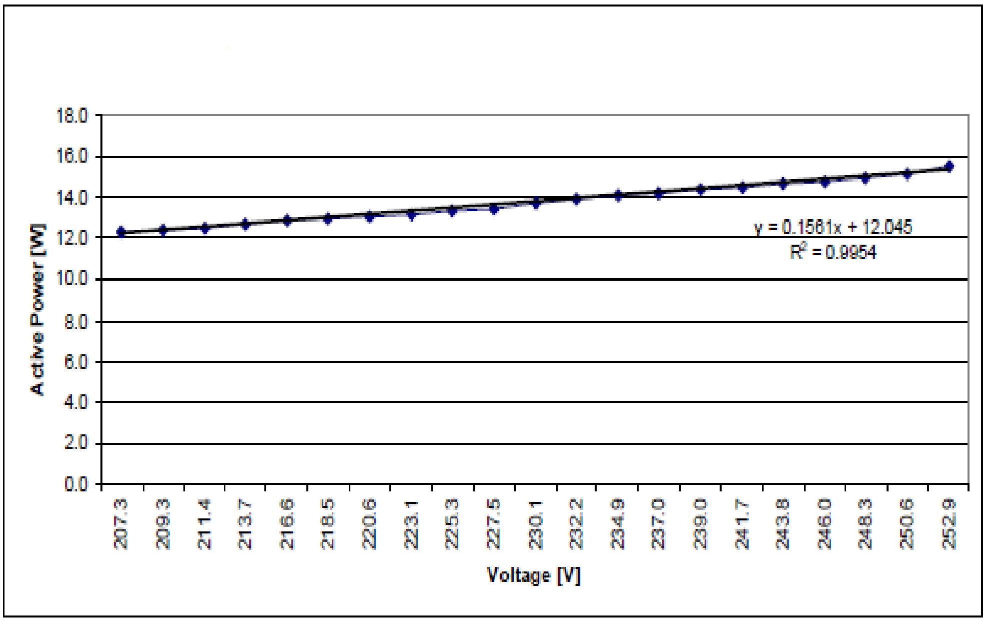

Fig 3: Measured active power versus voltage relationship for a 15w CFL lamp

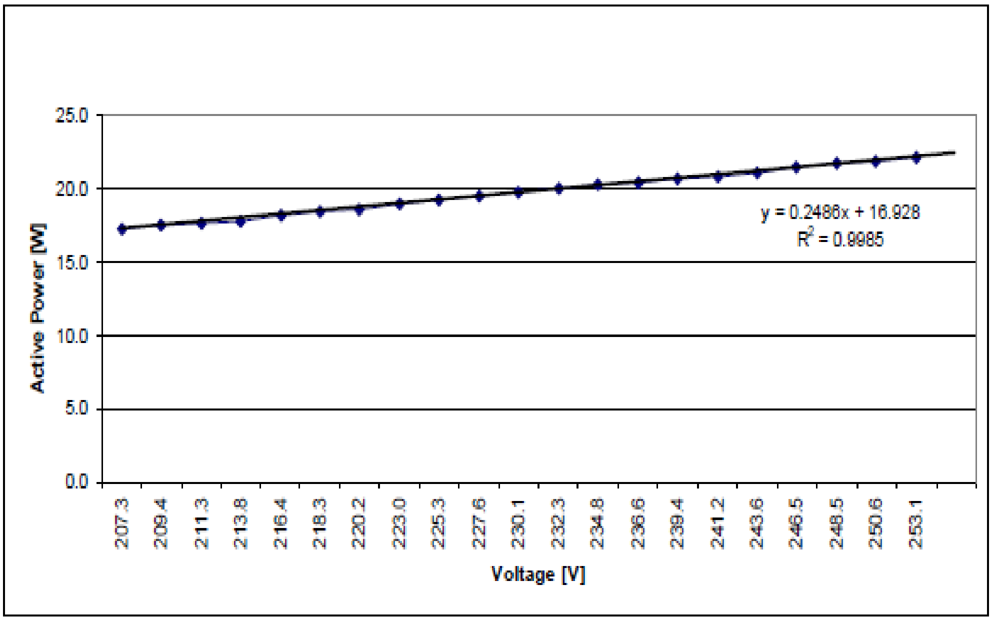

Fig 4: Measured active power versus voltage relationship for a 22w CFL lamp

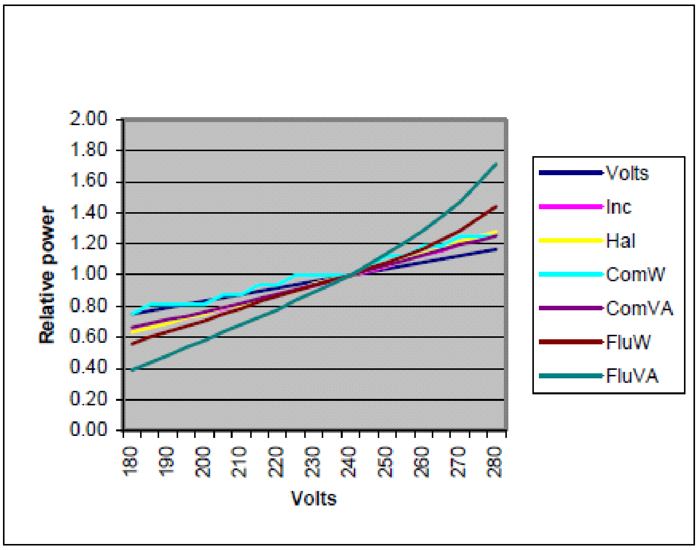

Fig 5: Variation in power consumption with voltage for different lighting fixtures

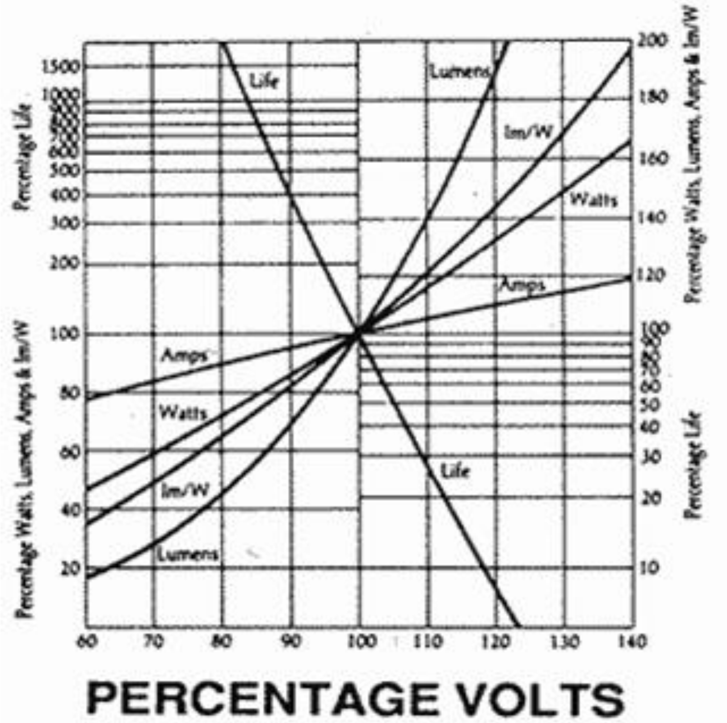

Fig 6 Effect of supply voltage variations on lamp efficacy, life, light output and electrical energy consumed

Table IV: Income Classification of households

Class	**Type**	**Number of Rooms**	**Number of cars/Garages**
1	Low income urban House	4 - 5	No car, No garage
2	Middle income urban Flat	3 - 5	One car, One/no garage
3	Middle income urban House	5 - 6	One car, One garage
4	High income urban	6 or >	2 cars, 2 garages
5	Growth point	4 or >	N/A

Table v: Sample Size based on Usage Group Sampling

Precision	20%	20%	10%
Confidence	80%	90%	90%
Z-Statistic	1.282	1.645	1.645
Population Size, N	**Sample Size, n***		
200	11	16	51
300	11	17	56
400	11	17	59
500	11	17	60
infinite	11	17	68

Table v shows the minimum sample size established, assuming a coefficient of variation of 0.5, as per IPMV recommendation for time of use. **Table vi** shows the stratified sample chosen by the M&V team in the initial customer survey. The number of households per class was deliberately chosen to be above the minimum requirement of 68 for improved accuracy.

IV. CUSTOMER SURVEY

In order to establish the installed capacity of incandescent lamps and the time of use for the lights, a survey was done covering one hundred households per classification. The study was done to establish the following:

- Percentage of installed lights per wattage type
- Typical operation hours
- Percentage of households with CFLs already installed
- Type of fixtures (Bayonet or Screw type)
- Diversity factor

The questionnaire used for the survey is shown in **Appendix A**. Sampling statistical analysis assumes that the data is normally distributed about the mean. Statistical validity was ensured by the samples being randomly selected.

Table VI: The Stratified Sample for the Preliminary Survey

Class	**Number of Houses in Sample**	**Chosen cities/growth points**	**Number of houses per city/growth point**	**Areas Surveyed**
1. Low Income Urban House	100	Harare	40	Mbare/Glen View 1
		Bulawayo	30	Nkulumane/Nketa/Luveve
		Masvingo	30	Rujeko
2. Middle Urban Income Flat	100	Harare	50	Avenues
		Bulawayo	50	Mpopoma
3. Middle income urban House	100	Harare	25	Houghton/Masasa Park
		Bulawayo	25	Mahachula
		Mutare	25	Yeovile
		Gweru	25	Irvine
4. High income urban	100	Harare	40	Mt Pleasant/Good Hope
		Bulawayo	30	Khumalo
		Chinhoyi	30	Orange Groove
5. Growth point	100	Gokwe	40	Gokwe Center
		Gutu	30	Gutu Center
		Bora	30	Bora Center

V. RESULTS

From a survey the average number of lights per household was established as shown on **Table vii**. The percentage of installed lights per fixture type was established as shown on **Table viii** below: The survey established that 30% of the lights currently operating are CFLs. Using the total population, the number of installed incandescent lamps as well as the CFL replacements is shown on **Table ix** below. The established numbers take into consideration the fact that ZETDC will install 5.5 million CFLs. The survey revealed household time of usage statistics profiles for each class as shown on **Fig 7-11.**

Table vii: Average Number of lights per Household

Class	Number of Lights
1	5
2	5
3	10
4	20
5	5
Average	**9**

The operational profile for holidays and Sundays will be merged since the profiles are almost the same and the number of holidays is small. The average operating hours for each class are shown in the **Table x**. The survey results also revealed that 5% of the installed incandescent lights are security lights that are only switched on at night. These are normally switched between 1800hrs and 0600hrs each day. A minimum of 20% of lights are normally switched on during the day except in situations where due to load shedding, households forget to switch off the lights and when ZETDC restores supply, there is no one at home to switch the lights off. These situations can be considered to be negligible for the measurement and verification exercise.

Table viii: Percentage of installed lights per Fixture Type per class

Class	100w	75w	60w	40w	CFLs	Total
1	17%	1%	50%	5%	27%	100%
2	26%	14%	27%	7%	26%	100%
3	9%	5%	26%	3%	57%	100%
4	9%	7%	42%	2%	40%	100%
5	28%	38%	25%	0%	9%	100%

This projects claim peak demand savings that require a diversity factor to be determined and applied to baseline and performance period to avoid over-counting demand reductions. During the initial survey, the diversity factor was calculated from the survey results as shown in **Table xi** below. The survey revealed that on average, 87% of the lights are on during peak demand. The savings calculated below assumes the following:

- 87% of the lights will be operating during evening peak demand from **Table xi** above.
- Voltages will be at their minimum during peak demand.
- Quantity of lights in system is as in **Table ix** from the Preliminary survey.

The expected savings would be:

$$S_E = D_I - D_C$$

Where: S_E = Expected Peak Demand Savings

D_I = Calculated peak demand for incandescent lamps in **Table xii**

D_C = Calculated peak demand for CFLs in **Table xiii**

S_E = 203,394kW

Table ix: The light distribution of incandescent and CFL lights

Incandescent	Wattage	100w	75w	60w	40w	Total
	Percent	20	18	57	5	100
	Number	1,100,000	990,000	3,135,000	275,000	5,500,000
CFL	**Wattage**	22w		15w		
	Number	2,090,000		3,410,000		5,500,000

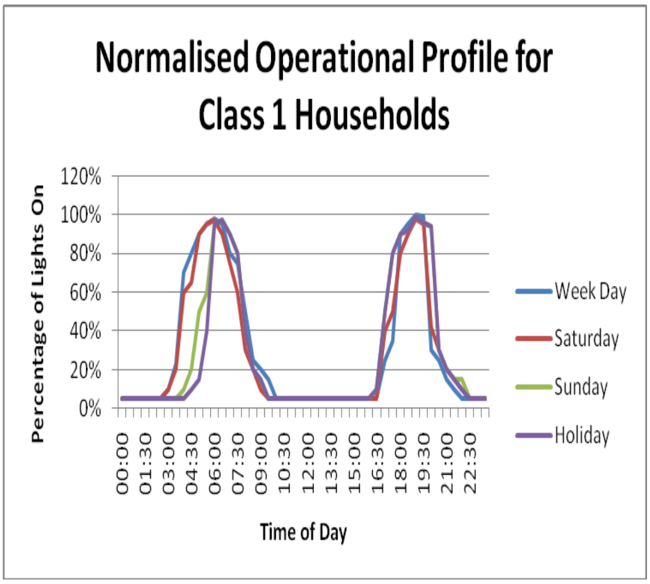

Fig 7: Operatinal Profile for Class 1 Households

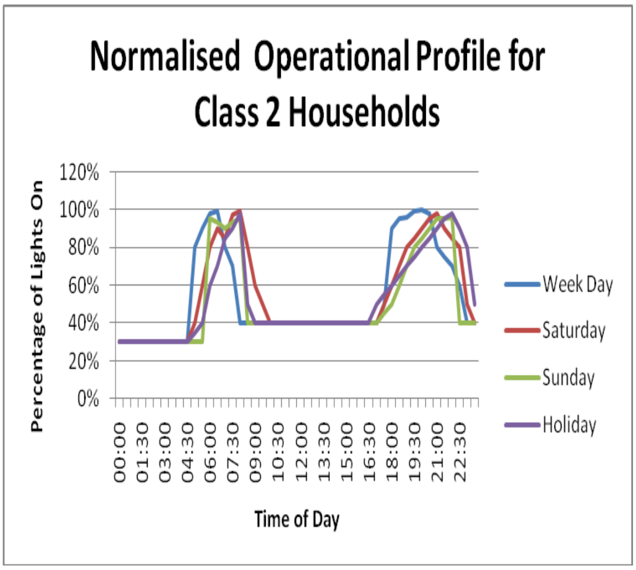

Fig 8: Operatinal Profile for Class 2 Household

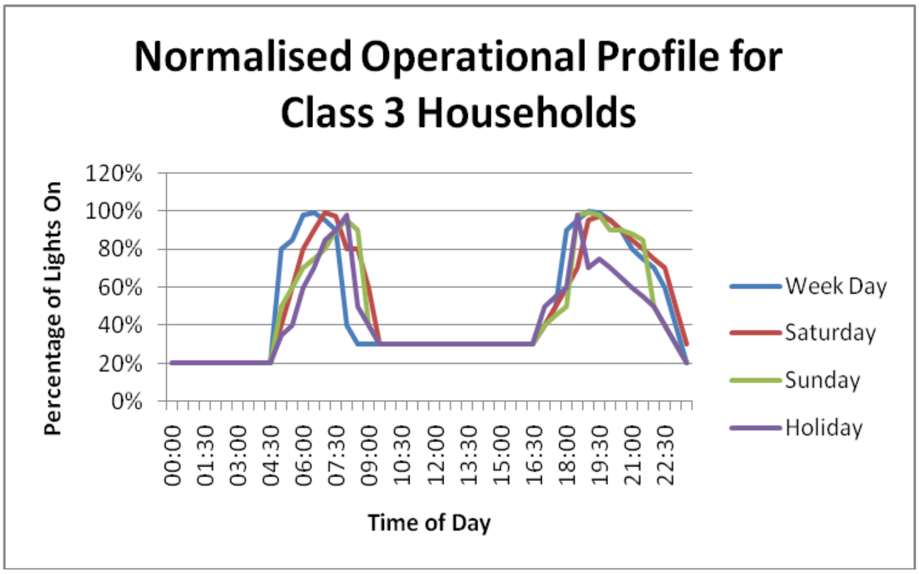

Fig 9: Operatinal Profile for Class 3 Households

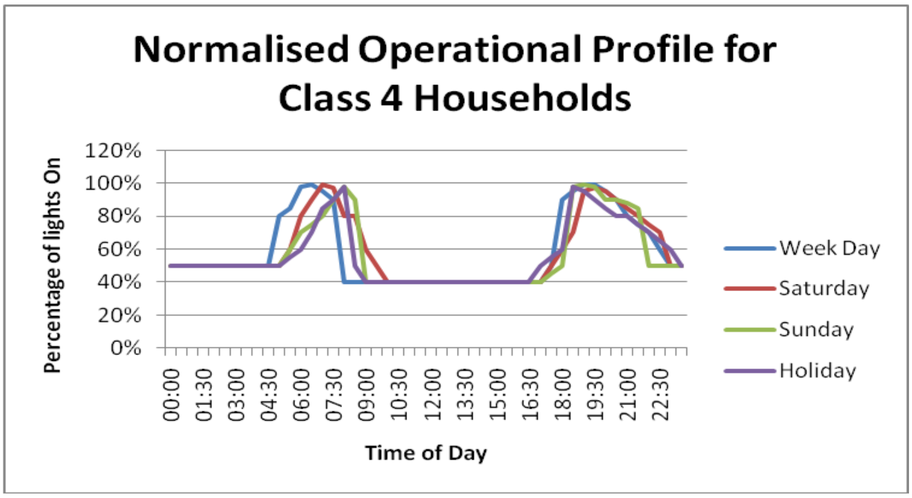

Fig 10: Operatinal Profile for Class 4 Households

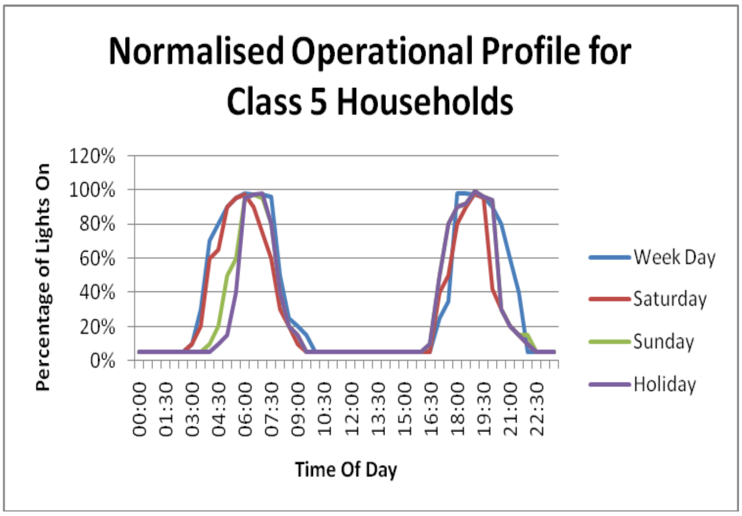

Fig 11: Operatinal Profile for Class 5 Households

Table x: Average Operating Hours per Class

Class	Average Operating Hours/day				Average
	Weekday	Saturday	Sunday	Holiday	
1	5	5	4	3	4.25
2	6	7	6	5	6.00
3	7	8	8	6	7.25
4	6	6	5	5	5.50
5	7	8	5	5	6.25
Average	6.20	6.80	5.60	4.80	5.85

Table xi: Diversity during peak demand

Class	% of Operating Lights During Morning and Evening Peak				Average
	Weekday	Saturday	Sunday	Holiday	
1	90	88	80	80	**84.50**
2	95	87	85	85	**88.00**
3	96	85	82	83	**86.50**
4	90	85	80	84	**84.75**
5	97	90	88	85	**90.00**
Average	**93.60**	**87.00**	**83.00**	**83.40**	**86.75**

Table xii: Expected Peak Demand from Incandescent Lights

Power Rating	Number of Lights in System	Rated Demand (Kw)	Number of Lights Operating (Diversity Factor) (87%)	Peak Demand at Rated Power (Kw)	Peak Demand with Voltage Influence (0.8165) (Kw)
100	1,100,000	110,000	957,000	95,700	78,139
75	990,000	74,250	861,300	64,598	52,744
60	3,135,000	188,100	2,727,450	163,647	133,618
40	275,000	11,000	239,250	9,570	7,814
Total	5,500,000	383,350	4,785,000	333,515	**272,315**

Table xiii: Expected Peak Demand from CFL Lights

Power Rating (w)	Number of Lights in System	Rated Demand (Kw)	Number of Lights Operating (Diversity Factor) (87%)	Peak Demand at Rated Power (Kw)	Peak Demand with Voltage Influence (0.8156) (Kw)
22	2,090,000	45,980	1,818,300	40,003	32,626
15	3,410,000	51,150	2,966,700	44,501	36,295
Total	5,500,000	97,130	4,785,000	84,504	**68,921**

VI. DISCUSSION AND RECOMMENDATIONS

Although we had expected differences in operating hours per class, the survey results revealed very little differences where they existed. The major difference between classes is on the lights that are on during the day. Although the survey results show us an average operating hours of 5.85 hours, the recommendation from IPMV where measurements are not done is 3.5 hours. This is a conservative figure that guarantees that the savings are not overstated. The average operating hours established is midway between the IPMV recommendation and ESKOM's established operating hours of 7.67 hours. From **Table x**, classes 2 to 5 have average operating hours per day above 6 hours. This is where the majority of CFLs will be installed. For that reason, the established average operating hours was rounded off to 6 hours when calculating the expected savings.

VII. CONCLUSIONS

From the literature review, Compact fluorescent light rollout projects done in South Africa, Ghana and Poland resulted in substantial demand savings being realized. The preliminary survey results established a minimum evening peak demand savings of 203MW. Sustainability of savings will be dependent on the rebound effect.

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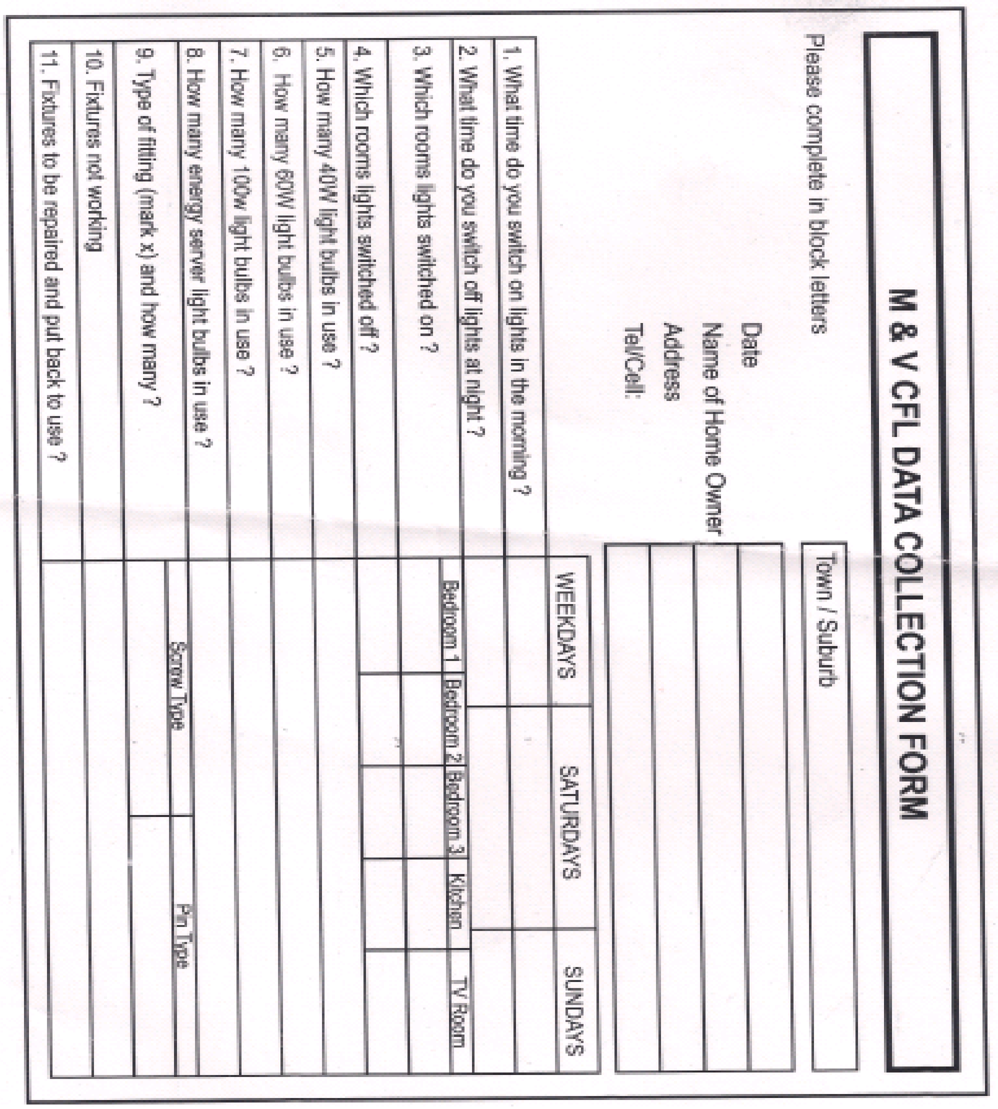
APPENDIX



M & V CFL DATA COLLECTION FORM

Please complete in block letters

Town / Suburb

Date
Name of Home Owner
Address
Tel/Cell:

	WEEKDAYS	SATURDAYS			SUNDAYS
1. What time do you switch on lights in the morning ?					
2. What time do you switch off lights at night ?					
	Bedroom 1	Bedroom 2	Bedroom 3	Kitchen	TV Room
3. Which rooms lights switched on ?					
4. Which rooms lights switched off ?					
5. How many 40W light bulbs in use ?					
6. How many 60W light bulbs in use ?					
7. How many 100w light bulbs in use ?					
8. How many energy server light bulbs in use ?					
	Screw Type		Pin Type		
9. Type of fitting (mark x) and how many ?					
10. Fixtures not working					
11. Fixtures to be repaired and put back to use ?					