Residence Hall Electrical Usage

Ryan Franchi, Jimmy Bruno

ENVS 410: Appropriate Technology and Sustainability – The Campus as a Living Laboratory

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I. Executive Summary

The project we chose to work on for the semester was an electrical audit of several rooms in the Ackley/Shilling residence halls to determine the amount of electricity used in each room, and specifically how much electricity each individual appliance draws. Upon conducting all electrical audits and organizing the data, we made several important discoveries regarding heavy consumers of electricity as perceived by the university. The common perception is that most electricity is used on computers and refrigerators. Our results showed that these do draw significant amounts of electricity, but usage has improved. Many residents turn their computers off and use standby modes while all mini-refrigerators had an electrical output under 1.75 kwh/d. Laptops use 25-45 Watts compared to the 150 Watts used by Desktop computers. Most residents use Laptops showing a difference from practices several years ago. An additional discovery is the power drawn by personal lamps and fans. Out of 21 energy audits there were a total of 29 lamps and 18 fans. The lamps ranged in power from 30-120 Watts. Only two residents used energy-saving technology by utilizing LED lights and CFL bulbs. Our equipment did not register a reading for the LED lights while the CFL bulbs read only 7 Watts for CFL bulbs. If WMU recommended the use of CFL bulbs in personal lamps, the energy bill reduction could result in $7,237.36 saved, based on 4000 residents. Fans also demonstrated an energy issue. Many residents use large box fans or smaller fans that

consume more power for long periods of time. If WMU recommended that residents only use box fans in the summer and keep personal fans set to a minimum level at night, electrical consumption would be further reduced. In light of these findings, we have decided on a few simple solutions to the electrical-overconsumption problem that should be both easy to implement, as well as effective at reducing the electrical load on the residence halls. To start, many rooms we audited had several lamps, sometimes 3 or 4 per room. Students frequently reported using at least one lamp in addition to the main room light, sometimes even more. If the quality of light from the overhead unit were improved, these lights may not be necessary. Also, laptops have been shown to use about one-third of the energy used by desktop computers, sometimes even more. If students purchase laptops over desktops, this will help lighten the load significantly in a room if there are two laptops instead of two desktops. Finally, many students had two minifridges in their room, even though most of the time all food could have fit in just one unit. Not having two fridges in a room, or simply unplugging one until the first fridge fills up would be an excellent way to save electricity. Our final recommendation lies with replacing the older microfridge units with new, energy-star rated models. The energy savings totals about $10,000 a year with a payback period of a 520 unit investment of ~3.5 years. Although this information should be helpful to the university, more work could be done to get a more accurate view of electrical habits of students in residence halls. For example, our sample size of 21 rooms provides a basic view of the types of appliances most frequently found in resident's dorms, but may be insufficient for drawing definitive conclusions. Also, this project is meant to be a stepping stone for more specific studies regarding residence hall electrical issues.

II. Introduction

As our campus attempts to move further towards a widespread focus on sustainability, the WMU Physical Plant has been pivotal in bringing our desire to conserve energy into reality. By completing programs such as the campus-wide conversion from inefficient lighting systems to highly efficient T8 florescent and LED lighting technology, alongside many other related projects, they have helped our school progress further down the path of sustainability. Unfortunately, the Physical Plant can only do so much to limit energy waste. If our campus is to become truly sustainable, the student body must learn how their actions affect the world they live in. Although efforts have certainly been made to educate the student body on many types of environmental issues, electrical demand in the residence halls is at an all time high, and has been rising for years. Since many of the residence halls' electrical systems are between 40-50 years old and will be in need of replacement or repair in the near future, we were asked to evaluate the electrical-use habits of WMU students living within the residence halls, in an effort to determine the average amount of electricity being drawn from individual rooms. In addition, we also wanted to know what appliances were drawing the most power in each room and how much electricity each one was consuming per day, and finally, the power consumption ratio between laptop and desktop computers. The ultimate objective of our investigation was to provide a detailed report that could serve as a basic data source to aid in future work related to campus conservation and construction. Providing data on what students most frequently use in their dorm rooms could aid in maintaining electrical systems and help leverage University resources to specific areas of improvement. The study could also be used to educate incoming students on the impacts of their habits and purchasing decisions, potentially leading to a more sustainable campus as knowledge spreads and students become more conscious of their actions.

III. Data and Methodology

An electrical audit was performed in order to attain baseline data to form the basis of recommendations and a procedure for future studies.

Scope

The scope or system boundaries of the study gauged the electricity use of current residents living in Ackley/Shilling hall as a representative for all other residence halls. Individual electricity usage may vary from hall to hall. The assumption is that all of campus is consistent with our 21 audits (~0.5% of the residence hall population). Also, audit values were based off estimated use by the resident. These values may be incorrect but measuring exact energy use over a long period of time with limited resources proved infeasible. Confronted with this boundary, we assume that the daily usage of appliances given to us by the residents is a constant value.

Additionally, representative values of kwh/d for University microfridges were taken and assumed constant throughout the hall. New models measured 0.57 kwh/d while old models measured 1.66 kwh/d. These values were obtained by testing two microfridges, an old and new model, over 24 hours and measuring the cumulative kwh draw and duty cycle. All microfridges were assumed constant with the representative values.

Procedure

Dr. Glasser provided two energy-reading devices to use in the course of these audits. The meters were plugged into outlets while the appliances were plugged into the back of the meters giving a power reading in Watts. An audit was initiated by obtaining permission from hall staff and knocking on residents' doors. The resident had to consent to an electricity audit that included unplugging their appliances and answering questions about daily usage. With permission we entered the room, plugged in our meters, and kept track of results with a notebook. Residents were encouraged to give approximate daily, weekly, or monthly totals in hours or minutes of how long the appliance was in use. We also measured the power when appliances were turned off but still plugged in and included values where appropriate. Appliances such as computers and fans were commonly given in hours per day while microwaves and hair dryers had values in minutes per week. All values were converted to hours per day in the final analysis.

Once each audit was complete we thanked the residents, consolidated data, and entered the findings into a spreadsheet. The spreadsheet lists each appliance followed by the power meter reading in Watts and the daily usage in hours. This value was converted to kwh/d through the formula:

$$\text{Kwh/d} = (\text{Watts}/1000)*\text{h/d} \qquad \textbf{(1)}$$

The values of kwh/d were converted to kwh/month by using a conversion of 30 days per month. A rough electricity bill was calculated with this value using a low-range price of $0.08/kwh and a high range price of $0.11/kwh. These values were summed at the bottom. Figure 1 on the following page shows an example of a complete energy audit while the Appendix section contains all 21 audits.

IV. Energy-Saving Initiatives on WMU's Campus

We know from speaking with Dr. Glasser that there have been projects done regarding residence hall energy audits in the past. However, the information that had been gathered is now outdated, and not available for public viewing. There have also

Table 1: Electricity Audit for 608 Ackley Hall, 2 Residents

Source	W	h/d	kwh/d	kwh/mth	$/month ($0.08/kwh)	$/month ($0.11/kwh)
Cell Phone Charger (Off)	1	0.429	0.0004	0.01	0.00	0.00
Cell Phone Charger (On)	1.6	23.57	0.0377	1.13	0.09	0.12
Clock	0.4	24	0.0096	0.29	0.02	0.03
Clock	1	24	0.0240	0.72	0.06	0.08
Computer (Laptop PC) Off	0	6	0.0000	0.00	0.00	0.00
Computer (Laptop PC) On	21	14	0.2940	8.82	0.71	0.97
Computer (Laptop PC) Standby	0.5	5	0.0025	0.08	0.01	0.01
Electric Sign	17.9	0.001	0.00001	0.0003	0.00	0.00
External Hard Drive (On)	7.2	24	0.1728	5.18	0.41	0.57
Fan	43	8	0.3440	10.32	0.83	1.14
Microwave	1066	0.001	0.0006	0.02	0.00	0.00
Minifridge	23.8	24	0.5700	17.10	1.37	1.88
Speakers (Off)	29	23.71	0.6877	20.63	1.65	2.27
Speakers (Off)	0	20	0.0000	0.00	0.00	0.00
Speakers (On)	180	0.285	0.0513	1.54	0.12	0.17
Speakers (On)	1	4	0.0040	0.12	0.01	0.01
TV (LCD) Off	0	14	0.0000	0.00	0.00	0.00
TV (LCD) On	265	10	2.6500	79.50	6.36	8.75
Xbox 360 (Off)	1.1	21	0.0231	0.69	0.06	0.08
Xbox 360 (On)	164	3	0.4920	14.76	1.18	1.62
			SUM	**160.91**	**12.87**	**17.70**

been other projects implemented aimed at reducing electrical consumption campus-wide, some of them in residence halls. So far, WMU has reduced the electrical load from lighting by replacing most of the old incandescent lighting systems with more efficient T8 fluorescent tube lights, Compact Fluorescent Lamps (CFLs) or high output Light Emitting Diodes (LEDs.) In Gabel Natatorium and Ice Arena, a heat recapturing system draws waste heat from the ice refrigeration system and uses it to heat the water in the swimming pool next door. Also, occupancy sensors installed in many rooms on campus save electricity by turning off lights when nobody is using the room.

These measures have all been taken by the WMU Physical Plant, with the goal of increasing the sustainability of our campus. However, these actions are focused on increasing the efficiency of existing campus infrastructure, rather than educating students and staff on methods for decreasing their personal contribution to the electrical grid. In addition, Mr. Sankey admits that the Physical Plant doesn’t have any information regarding the electrical-use habits of students in the residence halls, and feels that this information would be helpful as a tool for educating students about their habits and providing more relevant knowledge on the topic of energy conservation. This information would allow us to identify leverage points where students could easily reduce their electrical demands. By evaluating the habits of residence hall students, we hope to provide baseline data that can be utilized as a platform from which new conservation proposals may be launched.

V. Learning from Other Campuses

Several other campuses around the nation have made broad steps in addressing their energy usage habits, and one in specific has developed guidelines based off of information gathered regarding personal energy use habits on a room-by-room basis. Wellesley College in Massachusetts appears to be the only other college in the nation that has published information regarding self-implemented, room-by-room electrical usage audits aimed at reducing the amount of electricity used in the campus's residence halls. Furthermore, the students that conducted the surveys provide a distinction between intended electrical withdrawals, such as using a microwave to heat food, and "wasted" electricity. An example of wasted electricity would be lights left on when nobody is in the room, or the electricity constantly keeping a television's cathode-ray tube heated up so it can be used on demand versus waiting for the tube to heat up. In their survey, students at the university were asked to list the number and type of appliances in their room, followed by the number of hours per day on average each device was used. Results from the survey showed that Wellesley College residence halls accounted for about $214,262 in electrical consumption, with about $5,912 spent on wasted electricity. With an enrollment of only about 2,300 students, Wellesley College's bill for wasted electricity would pale in comparison to the bill at a college the size of WMU. Also, in their list of suggestions to the Wellesley Sustainability Advisory Committee, the authors of the Wellesley report recommend a sustainability workshop for incoming students, as well as altering the list of items to bring to the dorm room. These are both excellent ideas, and should be viewed as a great starting point for developing our own conservation programs on campus.

In addition, Oberlin College in Ohio conducted a study that aimed to discover whether real-time feedback of energy use in specific residence halls would have any effect on student habits. Two residence halls using a web-based automated meter reading system and 20 halls using traditional utility meters were included in a competition aimed at reducing electrical and water consumption. Residents were provided with consumption rates once a week in the 20 halls using utility meters, and round the clock in the two automated meter halls, and competed for two weeks for the lowest rate of consumption. The study found an overall reduction of 32% in electrical use campus wide, and a 55% drop in the two dorms using full-time monitoring. This indicates that students are likely to make changes to their habits if they are provided with more information on the impacts of their actions. If they were to be informed on the amount of energy individual appliances use, they may be more apt to make changes in their electrical-use habits, or to purchase more energy-efficient devices for their rooms.

VI. Discussion

The 21 electricity audits provide the basis for several recommendations that have the potential to make the WMU residence halls more sustainable. Recommendations are based on quantitative findings and suggestions for specific areas to educate residents. The discussion is broken into four sections: microfridge usage, lamp usage, general appliance usage, and advice for a future study.

Microfridge Usage

The WMU residence halls can save a large amount of money by updating the older Microfridge units to newer energy star models. Each residence hall rents out a minifridge-microwave combination at the beginning of the year for the price of $80 for both semesters. The units are manufactured by Microfridge and are referred to by this name. Each hall contains roughly 40 Microfridges for rental. This value is used in our analysis, though some halls distribute up to 60. The rental models are older and draw 1.66 kwh/d. As older models break the University is replacing them with new models complying with energy star ratings. These models draw 0.57 kwh/d.

Our study showed that refrigerators use a consistent amount of electricity and almost every available Microfridge is rented to students. This leads us to question: What if all Microfridges had an energy star rating? To answer this question, we calculated the total number of Microfridges that would need to be bought to meet University needs. Using the estimate of 40 units and 13 halls we obtained a rough estimate of 520 units total. The value of 13 halls is derived by combining valley halls (Ackley and Shilling share the same supply), the Big Four as two (Ernest and Smith Burnham share the same supply), and the Little 3 each having separate supplies. Sally Benson, Regional Account Manager of MacGray (the Microfridge distribution company) worked the 520 unit projection and completed price quotes for the new unit (MFA3) and a similar unit (2.9MF-7TP) that most closely resembles the old models with several added features. The MFA3 is priced at $325 while the 2.9MF-7TP is $350 (delivered price).

Table 2 was developed using the total units, price, and energy differences of the old unit and the MFA3 model. The value of kwh/y is obtained by multiplying kwh/month by 7 representing roughly the amount of time residents live in their room (8 months minus 1 month for winter and spring breaks). The price of $0.095/kwh is the average of $0.08 and $0.11 used in the audits.

Table 2: Comparison of Old Microfridge and MFA3 Model			
Units	Old Model	MFA3	Annual Energy Savings
kwh/d	1.66	0.57	**$11,307.66**
kwh/month	49.8	17.1	Upgrade Price
kwh/year	348.6	119.7	**$169,000**
$/yr ($0.095/kwh)	33.12	11.37	Payback Period
$/yr (520 Models)	17220.84	5913.18	**3.19 Years**

As indicated by the table, the difference in electricity price is over $11,000/year. Using the price of $350/unit, upgrading all the Microfridges would cost $169,000. From an electricity perspective, the payback from energy savings would take over 16 years. However, the halls charge $80/year for Microfridge rentals. Assuming the units are paid off, the University currently profits off the Microfridge rentals at around $24,350/year. Once 520 energy-efficient models are paid off the University will profit $35,500/year.

While corresponding with Sally Benson she presented the opportunity of switching to the 2.9MF-7TP model Microfridge. The model offers a separate compartment for freezer (much like the older model) and outlet chargers on the microwave allowing users to recharge electronics. With a value of 290 kwh/year the same evaluation was performed showing a smaller energy savings and payback period at the expense of a more quality microfridge. It is also important to note that the kwh/year rating quoted for the MFA3 was 325 while our tests showed 208 kwh/year based on 365 days. While this may be maximum operating capacity, a lower energy rating for the 2.9MF-7TP is promising and may prove more efficient than the MFA3. Table 3 summarizes the economic evaluation.

Table 3: Comparison of Old Microfridge and 2.9MF-7TP			
Units	Old Model	2.9MF-7TP	Annual Energy Savings
kwh/d	1.66	0.79	**$8,978.48**

kwh/month	49.8	23.84	Upgrade Price
kwh/year	348.6	166.85	**$182,000**
$/yr ($0.095/kwh)	33.12	15.85	Payback Period
$/yr (520 Models)	17220.84	8242.36	**3.60 Years**

The economic analysis proves that using energy efficient Microfridges draw less power, saves the University money in electricity bills, and creates a rental profit in excess of $30,000/year. We recommend that WMU upgrade Microfridges to energy star models, specifically the 2.9MF-7TP, in order to create more sustainable residence halls and generate a higher profit through the constant rental fee.

Lamp Usage

The residence halls can help improve sustainability by promoting the use of compact fluorescent light bulbs (CFLs). Personal desk lamps were second only to computers as the most popular item in the survey. The 21 electricity audits yielded results for 29 lamps. Out of the 29 lamps only one was fitted with CFLs and one other was LED. The use of CFLs would drastically cut down on energy use. As suggested by Dr. Glasser, we assumed that CFLs drew 25% of the power currently drawn from incandescent light bulbs. With this factor we can analyze the audits and create a rough model of the hall electricity bill.

Since CFL usage has potential to make the WMU residence halls more sustainable we propose two scenarios: the University provides CFLs to residents in exchange for their incandescent bulbs or promote the use of CFLs through handouts and in-hall passive programming. In order for the University to provide CFLs there would need to be assurance that the investment would pay for itself. The analysis was performed through several assumptions: the 29/21 ratio held constant throughout campus, average values of power draw remain constant, and the WMU residence halls house approximately 4000 residents. Table 4 shows the results of the financial analysis.

The average price of $0.095/kwh was again used and shows an average price difference of $7237.36 from current practices. The value of 4000 residents displays an average CFL at $2/resident. According to www.thebulb.com, buying wholesale CFLs

Table 4: Incandescent vs. CFL		
Unit	Incandescent	CFL
Scaling Factor	1.38	1.38
Total Lamps	5524	5524
kwh/month	14511	3628
kwh/yr	101577	25394
$.095/kwh	9,649.81	2,412.45
Average Price Difference: $7,237.36		

equivalent to 60W incandescent is $1.62 per bulb when buying packs of 80 for $130. Since this value is marketable for the energy savings we recommend that WMU, potentially the Physical Plant, promote sustainability by purchasing 5000 CFLs and exchanging them for incandescent bulbs used by the residents in their lamps. This action will save energy, money, and create an atmosphere of sustainability within the halls.

General Appliance Usage

The WMU residence halls contain a wide variety of electrical appliances used by the residents. Appliances of particular interest are personal computers, fans, and televisions.

Personal computers are the most popular item seen in the surveys. Going into the project we suspected that residents would prefer to keep their computers on all day, especially high-consumption desk tops, and some users may be unaware of standby mode. Our audits show that a majority of residents own laptops. Of this majority, very few kept their computers on all day; most users either placed them in standby mode or turned them off altogether. Standby mode used 0.5 Watts every time we measured a value. These sustainable practices already seem to be in place and would be well-complimented by further education and reinforcement. However, a few residents did keep their computers on all day, including all three desktop computer owners. All three of these computers drew about 160 Watts, using more power than microfridges. While using a laptop versus a desktop is a personal preference, further education on the power draw of desktops would be beneficial to the residents, especially those moving off campus and not suspecting the high electricity bill a desktop creates.

Fans represent another frequently used appliance that could use significant improvement. Out of the 21 audits there were 15 fans, varying in size and energy use. Personal fans and larger box fans themselves do not draw much power, but they are left on for long periods of time. Box fans draw the most power at about 50 Watts and can be found in many rooms during warmer weather. Our recommendation is not to forego the larger fans, but instead shut them off when residents leave the room. This option would also require education of residents concerning their electrical usage.

The final area of interest lies with sustainable television use. According to our audits, the 21 rooms contained 17 televisions. Most of the televisions were cathode ray (CR) while the remainder was LCD. We did not audit a room with a plasma television but will not discount their presence in the halls. Electrical usage depended on two factors: the size of the television and the volume. A higher volume level drew more power as did larger sets. LCD televisions drew more power on average based on these two observations. While most LCD televisions had a standby mode drawing 0.5 Watts, most

CR televisions drew a phantom load between 0.1 and 2.0 Watts depending on the size of the television. Drawing a definite conclusion on television usage is difficult since usage, practices, and preferences vary greatly with each resident. A uniform recommendation would be the education of residents concerning phantom loads and the correlation between volume level and electricity use.

Advice on Future Studies

This project served two purposes: identify specific areas that WMU can focus on to improve sustainability in the residence halls and provide baseline information for the Physical Plant, Residence Life, and future student groups who intend to use this work as a stepping stone. While the recommendations and baseline data have been laid out, here are several suggestions for future studies.

A larger sample size would increase the validity of the individual audits. Time constraints only allowed a month working two days a week to perform audits. Each audit took 15-30 minutes. A group of three or four working three days a week for two months could easily obtain 100 audits. A distribution of this size may be needed to affect larger leverage points for sustainable residence hall practices. If a group would like to go a different direction and use these results for the basis of educating the residence halls, a survey asking residents about specific appliances and their usage would be appropriate in determining if our conclusions have stayed consistent. Working with the WMU Physical Plant would also be of great importance. This project started as an energy audit focusing on heat in the residence halls. After consulting with the Physical Plant we found that there was little interest in that area and more in the realm of electricity use. This set us back an entire month and could have been avoided with better planning.

VII. Limitations/Future Possibilities

Although we do feel that our goals have been accomplished, there were several aspects of the project that we feel could be improved with additional time and a better plan for performing the actual audits. For example, many students were reluctant to allow us to unplug their computer or game console for various reasons. This made it especially difficult to get information on desktop PCs, or the difference on power consumption for one computer between on, standby and off settings. Also, it was hard to find rooms with both residents there at the same time. Since we needed permission to take readings of anything in the room from it's owner, this limited the amount of audit-ready rooms at any given time significantly. Finally, because the audits took place in late March through mid-April, people had begun bringing belongings home for the summer, which both left fewer people to sample in the dorms on weekends, and fewer appliances in rooms that allowed us to audit them. However, rooms that had most of their original appliances removed already were not sampled in an effort to avoid skewing the data.

In light of these facts, anyone planning to do additional work would be wise to run their audits as soon as possible, making an effort to avoid study-intensive timeframes such as the week leading up to midterms or finals, and holiday weekends. Also, it may be a good idea to run audits in dorms considered to be more suited to upperclassmen rather than freshman. This is both to see if there is a considerable difference in habits between older students, and because upperclassmen may be more inclined to stay in Kalamazoo more weekends than freshmen, and possibly more likely to participate in the auditing process.

VIII. Conclusions and Recommendations

It would seem that the most appropriate actions for students to take are generally pretty easy, usually requiring only forethought. For example, if future roommates collaborate before reaching the residence halls on what each one is planning on bringing with them, there would hopefully be fewer rooms with multiple appliances like fridges and lamps. Purchasing Energy Star rated fridges is another easy way to reduce electrical demand, especially microfridges of the brand rented to students by the university. Kicking energy-wasting habits such as the tendency to leave the television on while sleeping or out of the room is another important but seemingly overlooked way to conserve. Finally, the low number of CFL bulbs found in lamps audited may indicate a potential leverage point for Physical Plant employees to reduce electrical loads by promoting the use of CFL bulbs over inefficient incandescent ones. A program where the Physical Plant purchases upwards of 5000 CFL bulbs and exchanges them for incandescent used by the residents may promote an atmosphere of sustainability within the halls.

As we have seen firsthand, there are many high-leverage points from which we can work towards reducing our demand on our environment. With some careful planning and an educated campus eager to improve the world around them, this study should provide a stable handhold in our climb up the ladder of sustainability.

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X. Contacts

1. Author's Contact List

Ryan Franchi – ryan.j.franchi@wmich.edu (248) 229-2863

Jimmy Bruno – james.e.bruno@wmich.edu (708) 927-5810

2. Reference Contact List

Sally Benson – Sbenson@MACGRAY.com (630)961-2979

Harold Glasser – harold.glasser@wmich.edu (269) 387-2713

Anand Sankey – anand.sankey@wmich.edu (269) 387-8579

XI. Appendices

Appendix A – Light Bulb Usage Calculations

Table A.1: Current Light Bulb Usage						
Source	**Watts**	**h/d**	**kwh/d**	**kwh/month**	**$/month ($0.08/kwh)**	**$/month ($0.11/kwh)**
Lamp	36.8	0.0208	0.00077	0.023	0.0018	0.0025
Lamp - 1	23.1	6	0.1386	4.16	0.33	0.46
Lamp - 2	37	3	0.1110	3.33	0.27	0.37
Lamp - 3	37	3	0.1110	3.33	0.27	0.37
Lamp - 1	52	2	0.1040	3.12	0.25	0.34
Lamp - 2	136	6	0.8160	24.48	1.96	2.69
Lamp	54	0.143	0.008	0.23	0.02	0.03
Lamp - 1	35.8	2	0.0716	2.15	0.172	0.236
Lamp - 2	86	2	0.1720	5.16	0.413	0.568
Lamp - 1	50.2	4	0.2008	6.02	0.482	0.663
Lamp (On)	22.6	0.333	0.0075	0.23	0.018	0.025
Lamp - 1	59.8	0.047619	0.0028	0.09	0.007	0.009
Lamp - 2	55	7	0.3850	11.55	0.924	1.271
Lamp - 1	10.6	7	0.0742	2.23	0.178	0.245
Lamp - 2	18	1	0.0180	0.54	0.043	0.059
Lamp	36	0.286	0.0103	0.31	0.025	0.034
Lamp	35	3	0.1050	3.15	0.252	0.347
Lamp - 1 (On)	41.1	4	0.1644	4.93	0.395	0.543
Lamp - 2	36.8	0.142857	0.0053	0.16	0.013	0.017
Lamp - 3	36.6	0.142857	0.0052	0.16	0.013	0.017
Lamp - 1	5	0.00238	0.00001	0.00036	0.00003	0.00004
Lamp - 2	60	1	0.0600	1.80	0.144	0.198
Lamp (LED)	0	4	0.0000	0.00	0.000	0.000
Lamp	56.4	0.143	0.01	0.24	0.019	0.027
Lamp - 1	44.8	1	0.04	1.34	0.108	0.148
Lamp - 2	6.9	0.0006	0.00	0.00	0.000	0.000
Lamp - 3	36	0.143	0.01	0.15	0.012	0.017
Lamp	92	2	0.18	5.52	0.442	0.607
Lamp	38.5	0.033	0.001	0.04	0.003	0.004
AVERAGE	42.72	2.05	0.09	2.63	0.21	0.29

Table A.2: 100% CFL Usage Projection						
Source	**Watts**	**h/d**	**kwh/d**	**kwh/month**	**$/month ($0.08/kwh)**	**$/month ($0.11/kwh)**
Lamp	9.2	0.0208	0.0001	0.006	0.0005	0.0006
Lamp - 1	5.775	6	0.0346	1.040	0.0832	0.1143
Lamp - 2	9.25	3	0.0277	0.833	0.0666	0.0916
Lamp - 3	9.25	3	0.0277	0.833	0.0666	0.0916
Lamp - 1	13	2	0.0260	0.780	0.0624	0.0858
Lamp - 2	34	6	0.2040	6.120	0.4896	0.6732
Lamp	13.5	0.143	0.0019	0.058	0.0046	0.0064
Lamp - 1	8.95	2	0.0179	0.537	0.0430	0.0591
Lamp - 2	21.5	2	0.0430	1.290	0.1032	0.1419
Lamp - 1	12.55	4	0.0502	1.506	0.1205	0.1657
Lamp (On)	5.65	0.333	0.0018	0.056	0.0045	0.0062
Lamp - 1	14.95	0.04761	0.0007	0.021	0.0017	0.0023
Lamp - 2	13.75	7	0.0962	2.888	0.2310	0.3176
Lamp - 1	2.65	7	0.0185	0.557	0.0445	0.0612
Lamp - 2	4.5	1	0.0045	0.135	0.0108	0.0149
Lamp	9	0.286	0.0025	0.077	0.0062	0.0085
Lamp	8.75	3	0.0262	0.788	0.0630	0.0866
Lamp - 1	10.27	4	0.0411	1.233	0.0986	0.1356
Lamp - 2	9.2	0.14285	0.0013	0.039	0.0032	0.0043
Lamp - 3	9.15	0.14285	0.0013	0.039	0.0031	0.0043
Lamp - 1	1.25	0.00238	0.0000	0.000	0.0000	0.0000
Lamp - 2	15	1	0.0150	0.450	0.0360	0.0495
Lamp (LED)	0	4	0.0000	0.000	0.0000	0.0000
Lamp	14.1	0.143	0.0020	0.060	0.0048	0.0066
Lamp - 1	11.2	1	0.0112	0.336	0.0269	0.0370
Lamp - 2	1.725	0.0006	0.0000	0.000	0.0000	0.0000
Lamp - 3	9	0.143	0.0012	0.039	0.0031	0.0042
Lamp	23	2	0.0460	1.380	0.1104	0.1518
Lamp	9.625	0.033	0.0003	0.010	0.0008	0.0011
AVERAGE	10.68	2.05	0.02	0.66	0.05	0.07