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Computer Energy Use: How Does Awareness Impact Behavior?

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Introduction

Desktop computers consume an average of 60-500 watts when in active use, whereas in standby energy use drops to 2-6 watts. The amount of energy computers use varies within this range based upon monitor size and whether it is a Liquid Crystal Display (LCD) or a Cathode Ray Tube (CRT). LCDs and CRTs differ in the way that they produce light and images, however, a CRT computer monitor will typically use more energy, primarily because it is a larger monitor. Translated into kilowatt hours, a computer using 60 watts for one hour will use 60 watt hours or .06kWh. With the current average price at $0.13 per kWh and assuming that most computers are left on for 24 hours a day, the cost ranges from $68-$568 per computer per year. Assuming there are roughly 3,300 computers in labs and offices and 7,000 personal computers in dorms, URI could be spending anywhere from $700,000 to over $5M annually to power computers. The amount of kWh used on this many computers is equivalent to 3,930-32,760 metric tons of carbon dioxide emissions per year ($MtCO_2e$/yr). This is equal to a minimum of 1,000 cars with a 30mpg rating driving the national average of 33 miles per day for one year, or a minimum of 2,600 homes with an average of 30 incandescent bulbs running for 1,000 hours, or 42 days straight. Since the average tree in North America removes $0.0725MtCO_2e$ per year, one would have to plant at least 55,000 trees to remove the CO2 emissions from these computers ("Climate Change: The Multiplier Effect", 2008).

The power management settings on computers can be accessed by users through the control panel and information on how to make adjustments to these settings is readily available. The Energy Star program "EZ Wizard" provides help to those users who are unfamiliar with their computer's available power settings. By clicking a single icon on Energy Star's website they can follow easy guidelines and choose from a list of automatic power settings. There are also programs such as vPro, used by higher education institutions that allow one individual on a single computer to control the management settings on an entire network of computers. Although useful, these programs are expensive. This study will evaluate whether education alone can reduce computer energy use.

In Spring 2009 a pilot study was completed at the University of Rhode Island's Kingston Campus to examine whether a basic message encouraging users to put their computer in standby mode would decrease computer energy use. The computer lab in the Honors Lounge in Lippitt Hall was monitored for three weeks and messages were displayed on the desktop backgrounds of computers to encourage the switch to standby mode. Energy use decreased over the three week period but the decrease may not have been a direct result of the messages. Additional variables, such as free printing access in the

lab, a lack of a constant control, and the students' inability to reactivate computers in standby mode may have affected the results of the pilot study.

The variables that may have affected the results of the pilot study were addressed in a second study conducted in Spring 2010. The second study sought to create a more accurate baseline of current energy use and to assess student attitudes and level of awareness towards computer energy use in order to develop the educational message. The remaining objective was the same as in the pilot study: to measure the effectiveness of providing a simple educational message to encourage computer users to put their computers in standby mode when not in use and to distribute results to raise awareness to the student body and campus officials.

Methods

Creating a Baseline

Kill A Watt EZ meters were secured to three computers in the Honors Lounge in Lippitt Hall. Five days a week for three weeks, the meters were set at 9:30am and readings were taken at approximately 4:30pm in order to measure usage during the lab's hours of operation. Readings from the meters included voltage, kWh used, time elapsed, total cost during elapsed time, cost per hour, day, week, month, and year for each individual station. The cost per kWh was preset in the meters at $0.131/kWh, the rate which URI pays.

Developing and Administering a Survey

After seeking approval from the Institution Review Board on campus to conduct human research, a survey was created in order to inventory computer use in campus labs and to quantify students' awareness of energy use issues. Students were asked how often they utilized the labs on campus and how important they felt it was for them and for the campus to engage in sustainable activities that saved either energy or money. Before the survey was administered, the survey was piloted to ensure that questions were not biased, the survey was of appropriate length, and would be easily understood by students of various majors and class standings. After the pilot survey was completed and appropriate changes were made, the survey was administered to students in the URI Honors courses. (See Appendix 1 for the final survey.)

Assessing the Effect of an Educational Message

After the baseline period was complete, a message was posted on lab walls to encourage users to put their computer into standby mode when finished with their work. The message provided clear instructions to not only utilize standby mode but to also reactivate computers. Computers were monitored for three additional weeks after the post. (See Appendix 2 for the educational message.)

Results

Baseline Results

Over the three week baseline period, stations 1 and 2 each used an average of 0.73kWh per day. Station 3 used an average of 0.78 kWh per day. This equates to a cost of $120.00 per year for stations 1 and 2 and about $130 per year for station 3. (See Appendix 3 and 4 for results.)

Survey Results

All students who were surveyed reported that they were familiar with the term "standby mode". However, only 64% actually utilized standby mode. A slightly smaller percentage of students (60%) reported that they would be willing to take the time and effort to learn about power settings on their personal computer. Students appeared to be more concerned with the benefits of saving money by reducing computer energy use rather than the benefits of saving energy. About 70% of students strongly agreed that URI should make an effort to save money, whereas only about 50% of students surveyed strongly agreed that URI should make an effort to save energy.

Effect of Educational Message

After the educational message was posted, there was a decrease in energy consumption on stations 2 and 3 over the three week monitoring period but there was an increase in consumption on station 1. When the results were averaged, energy use and yearly cost of all stations combined remained unchanged. (See Appendix 3 and 4 for results.)

Discussion

Although there was a change in energy consumption after the message was posted on lab walls in 2 out of the 3 stations, there was an increase in energy consumption at the third station. This may be due to the station's location in the lab. Another problem noted was that during the day students plugged additional appliances into the power strip that was secured to the energy meter, which may have affected the meter readings. A future study should ensure that the meters measure the energy consumption of the computers without additional appliances. Because of these issues, the effectiveness of the educational poster in reducing energy use cannot be determined.

To gain a more accurate assessment of the impact of the poster on computer energy use, it may be essential to create a login system where students must sing in and out of computers. This would allow researchers to determine overall daily use of each computer so that a change in energy use could be more clearly correlated with students putting the computer in standby versus simply not using the computer.

A final bias regarding the results is the study's time period. The baseline data for this study were collected at the beginning of the semester and the data after the message was posted were collected at the closing of the semester. Since the level of homework students have can differentiate from the beginning of the semester to the end, this timeline could have greatly affected the results. The energy use after the message was posted may be dependent on the amount of work students' have and their demand for computers rather than the message itself. In order to address this problem in a future study, the baseline period should cover an entire semester or, if possible, even an entire year. This would allow for an average energy consumption level to account for any differentiations in assigned work throughout the semester.

The results of this study will be used to raise awareness and alert campus officials that a campus-wide computer policy may be imperative to reduce our energy consumption from computers. It is important for this project to expand in scope to additional labs and offices on campus to provide more data in support of policy implementation. Potential policies are those outlined in URI's Climate Action Plan, submitted in January 2010. These include campus-wide nightly monitor and computer shutdowns.

In a future study, a more accurate inventory of on campus computers and use must be established along with a lengthy baseline. A post study survey of attitudes and awareness would also provide further feedback and may help assess whether students acknowledged the message on lab walls and followed the procedure suggested by the message.

Conclusion

This study was successful in addressing the variables of a pilot study conducted the previous year. It is still difficult to predict, however, whether or not the changes in energy consumption in the on-campus lab are due to the posted message without a future study to provide more insight. The support of university officials is needed to implement a computer policy paired with appropriate educational programs that will produce a decrease in energy consumption throughout the entire campus.

References

Alander, Link, and Oscar Ramos. "Defining and Measuring Green Computing." Audio blog post. 20 May 2009.

American Museum of Natural History. "Climate Change: The Multiplier Effect." October 2008. http://www.amnh.org/education/resources/rfl/web/climatechange_interactives/multiplier/

"EZ Wizard : ENERGY STAR." Home : ENERGY STAR. 21 May 2009 <http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_ez_wiz>.

Appendix 1

Computer Energy Use Survey

This survey is being conducted as an effort to inventory how computers are being used in the Honors Lounge as part of a larger project on campus to minimize energy use in all labs. The results of this study will help develop educational programs or lab policies to reduce URI's energy consumption through computer use.

Do not worry about whether or not you are providing the "correct" answer to each question- the study is more interested in gathering the opinions and information about the general knowledge of students toward computer energy use. Your answers are anonymous, will remain confidential, and your participation is voluntary.

Thank you so much for your time and help with this study!

On average, how often do you use the computers in any lab on campus?

- ☐ Daily
- ☐ 1-3 times a week
- ☐ 1-2 times a month
- ☐ 1-2 times a semester (rarely)

On average, how often do you use the computers in the Honors Lounge?

- ☐ Daily
- ☐ 1-3 times a week
- ☐ 1-2 times a month
- ☐ 1-2 times a semester (rarely)

Do you have your own personal computer?

- ☐ Yes
- ☐ No

If you answered yes to previous question, is your personal computer a desktop or laptop?

- ☐ Desktop Computer
- ☐ Laptop
- ☐ Other

On average, how many hours per day do you use your personal computer?

- ☐ 0-2 hours
- ☐ 2-4 hours
- ☐ 4-6 hours
- ☐ More than 6 hours

Are you familiar with the term "power settings"?

- ☐ Yes
- ☐ No

If you answered yes to the previous question, have you accessed the power settings on your own personal computer?

- ☐ Yes
- ☐ No

Are you familiar with the term "standby mode?"

- ☐ Yes
- ☐ No

If you answered yes to the previous question, do you utilize "standby mode" on your personal computer?

- ☐ Yes
- ☐ No

Which of the following occur when your computer is not in use: Please check all that apply

- ☐ Monitor is turned off
- ☐ Computer is in standby mode
- ☐ Computer is shut down
- ☐ Computer remains on all day (screen and PC)
- ☐ I don't know

Which of the following practices would you do on a regular basis if you knew it would help save energy at URI?

	I already do this	I don't do this but am willing to	I am not willing to do this	I don't know	Not applicable
Limit the number of hours I use the computer labs	⟳	⟳	⟳	⟳	⟳
Limit the number of hours I use my personal computer	⟳	⟳	⟳	⟳	⟳
Turn my computer off over night	⟳	⟳	⟳	⟳	⟳
Allow my computer to hibernate over night	⟳	⟳	⟳	⟳	⟳
Utilize standby mode	⟳	⟳	⟳	⟳	⟳
Learn about the various power settings on my computer (auto standby mode/hibernation)	⟳	⟳	⟳	⟳	⟳
Turn my screen off each time I am finished using it	⟳	⟳	⟳	⟳	⟳
Turn my computer off (PC and screen) each time I am finished using it	⟳	⟳	⟳	⟳	⟳

On a scale of 1 to 5 with 1 being "I strongly agree" and 5 being "I strongly disagree", please tell us how you feel about the following statements:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
It is important to save energy	☐	☐	☐	☐	☐
It is important to save money	☐	☐	☐	☐	☐
URI should make an effort to save energy	☐	☐	☐	☐	☐
URI should make an effort to save money	☐	☐	☐	☐	☐
I can save energy by changing some of my everyday habits	☐	☐	☐	☐	☐
I can save energy if I reduce the number of hours I use my computer	☐	☐	☐	☐	☐
I can save energy if I learn about the power settings on my computer	☐	☐	☐	☐	☐

Optional

Thank you for taking your time to complete this survey. The following questions are optional. If you could, please tell us:

I am:

- ☐ Male
- ☐ Female

My age is: [____]

My major is: [____]

I am a:

- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior
- ☐ Graduate Student

Are you an Honors student?

- ☐ Yes
- ☐ No

Do you live on campus? "On campus" includes all dormitories, fraternities, sororities, and gateway apartments

- ☐ Yes
- ☐ No

Appendix 2

Educational Message

Sleep is good!

If you set your computer to sleep or standby mode you can help eliminate up to 90% of your current energy use, save money, and save the environment!

Please put your computer to sleep when you're done using it.

HOW TO PUT IT TO SLEEP:
Go to the Start Menu
Click on Turn off Computer
Choose the Standby Option

HOW TO WAKE IT UP:
Move the mouse or press any key

Appendix 3
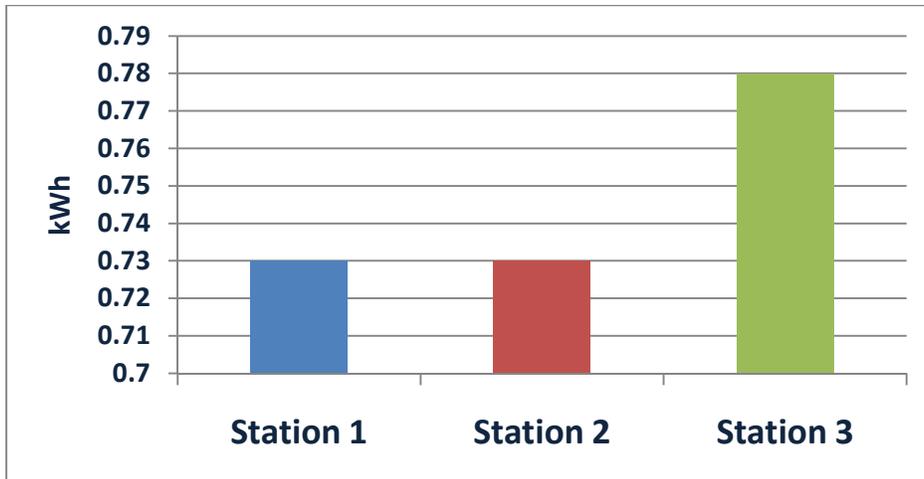
Figure 1. Average energy use of each station during baseline period
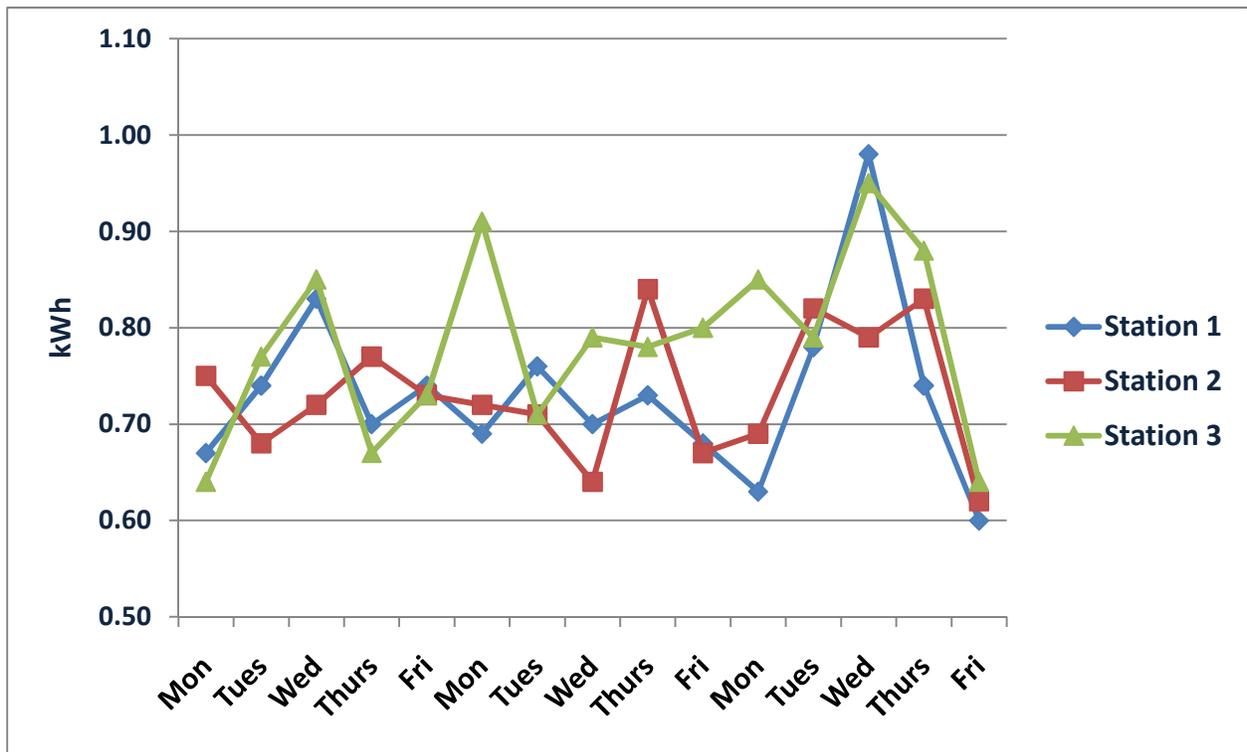
Figure 2. Daily energy use for each station during the three week baseline period
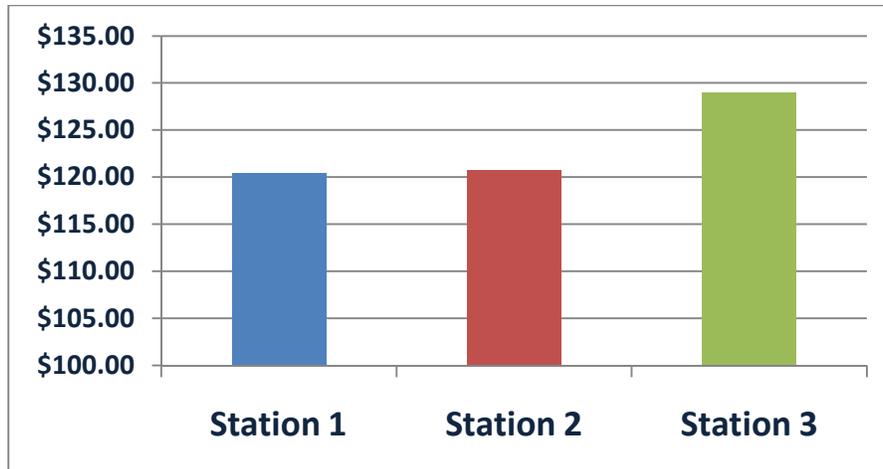
Figure 3. Estimated yearly cost of each station in accordance to average energy use over baseline period
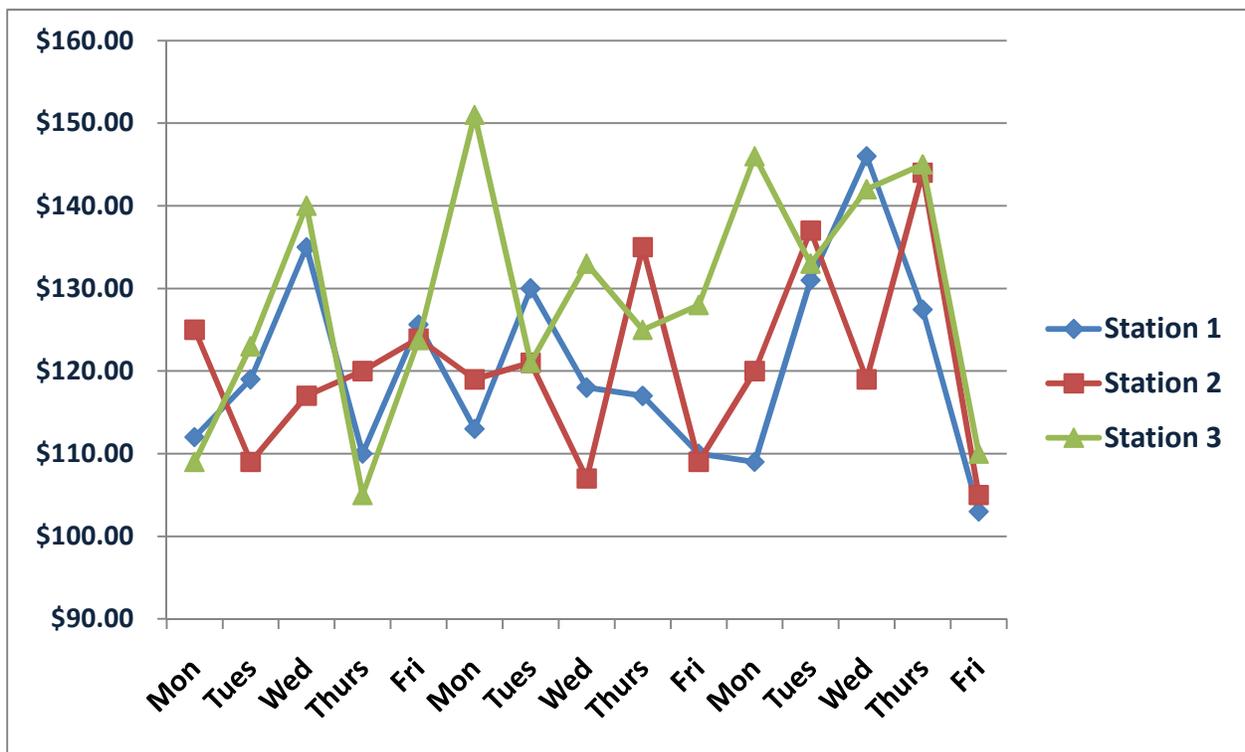
Figure 4. Estimated yearly cost based on daily use for each station during the three week baseline period
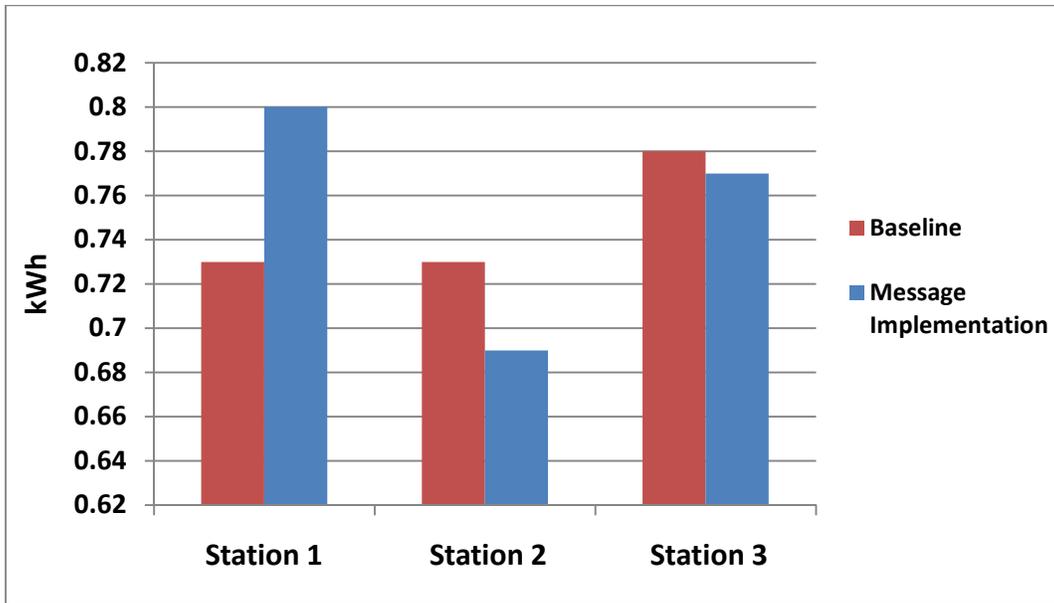
Figure 5. Average energy use of each station before and after message implementation

Figure 6. Daily energy use for each station over the three week period after message implementation

Figure 7. Estimated yearly cost of each station in accordance to average energy use before and after message implementation

Figure 8. Estimated yearly cost based on daily use for each station for the three week period after message implementation

Appendix 4

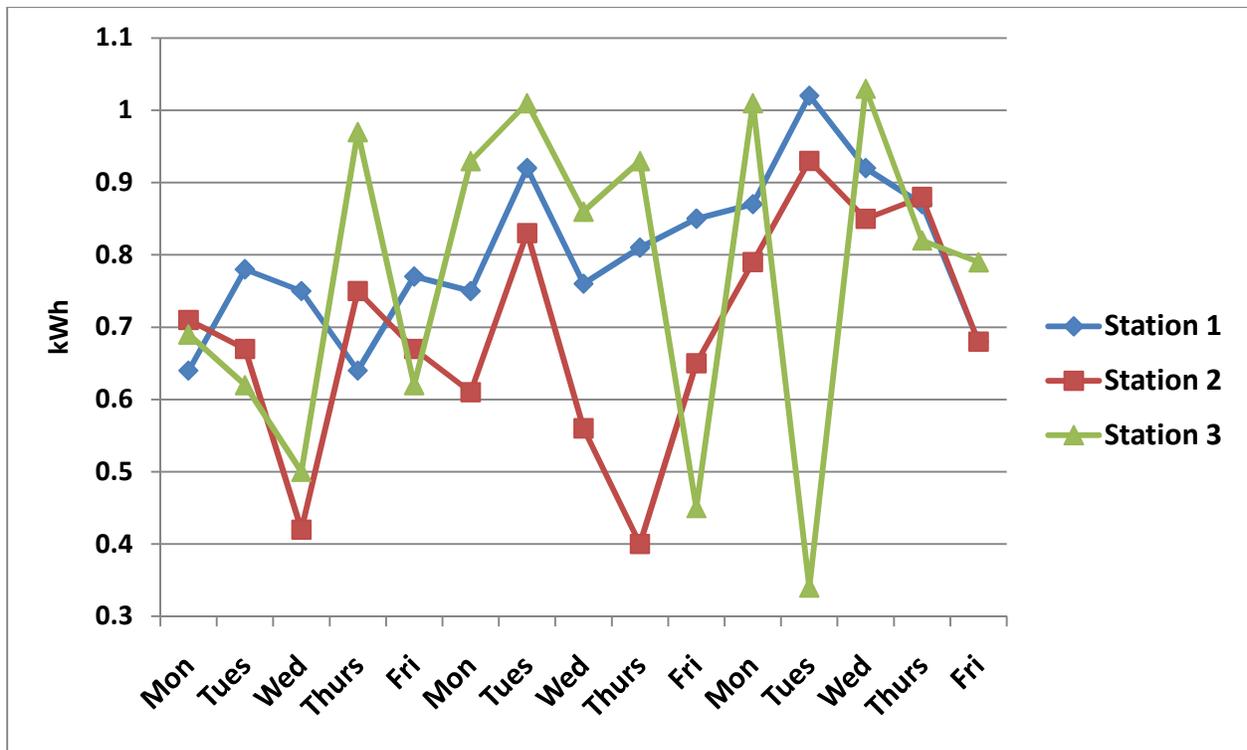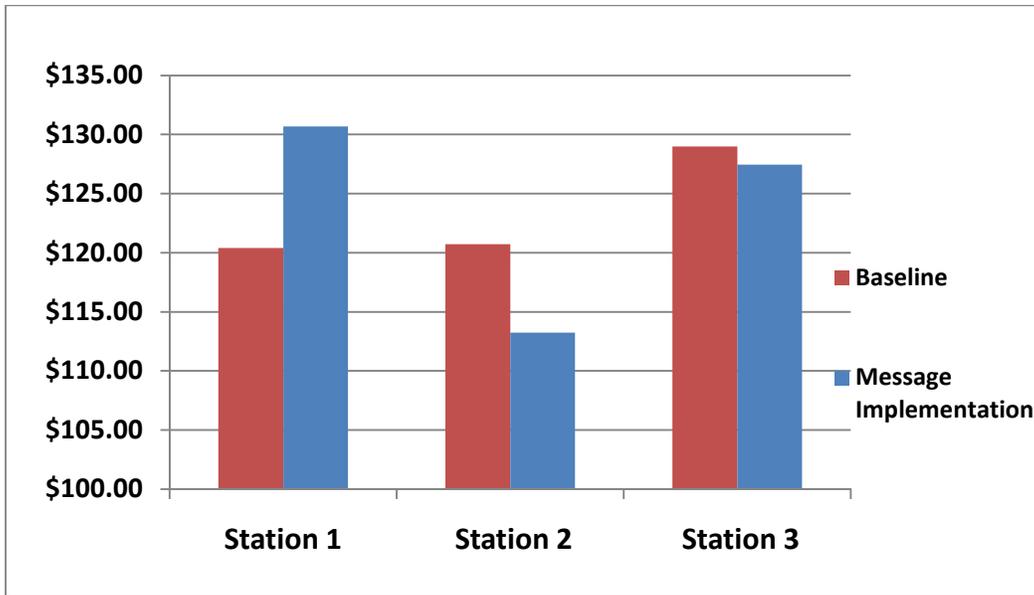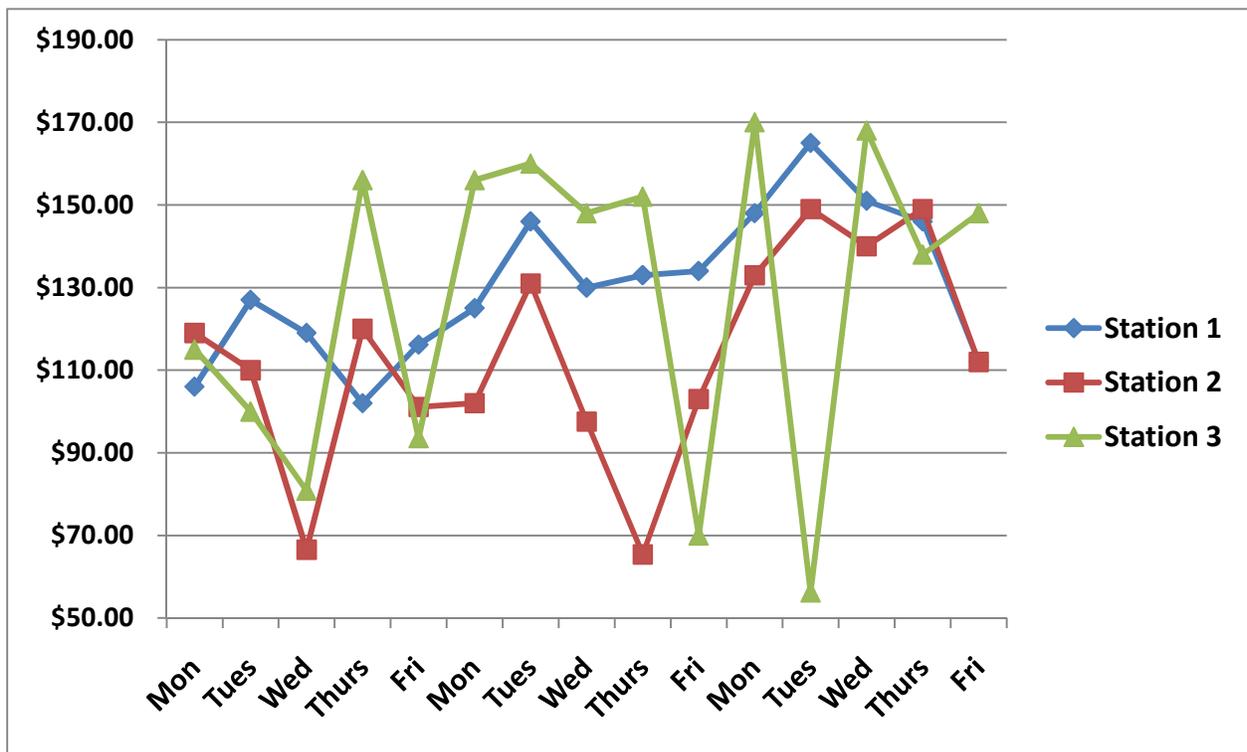|				BASELINE DATA FOR STATION 1					
DATE	Time Elapsed	Voltage	Total kWh	Total Cost	Cost/Hour	Cost/Day	Cost/Week	Cost/Month	Cost/Year
3/1/2010 AM	NA	NA	NA	NA	NA	NA	NA	NA	NA
3/1/2010 PM	6:47:00	117.4	0.67	$0.08	$0.01	$0.30	$2.15	$9.24	$112.00
3/2/2010 AM	16:50:00	118	1.27	$0.16	$0.00	$0.23	$1.65	$7.07	$86.06
3/2/2010 PM	7:10:00	117.4	0.74	$0.09	$0.01	$0.32	$2.28	$9.80	$119.00
3/3/2010 AM	17:04:00	117.2	1.56	$0.20	$0.01	$0.28	$2.00	$8.58	$104.00
3/3/2010 PM	7:00:00	117.4	0.83	$0.10	$0.01	$0.37	$2.59	$11.12	$135.00
3/4/2010 AM	16:41:00	118	1.34	$0.17	$0.01	$0.25	$1.76	$7.54	$91.80
3/4/2010 PM	7:19:00	117.9	0.7	$0.09	$0.01	$0.30	$2.11	$9.05	$110.00
3/5/2010 AM	16:52:00	117.5	1.31	$0.17	$0.01	$0.24	$1.69	$7.26	$88.36
3/5/2010 PM	7:00:00	117.5	0.74	$0.10	$0.01	$0.33	$2.33	$10.47	$125.63
3/8/2010 AM	64:55:00	117.7	4.71	$0.62	$0.01	$0.22	$1.59	$7.18	$86.12
3/8/2010 PM	6:56:00	118.3	0.69	$0.09	$0.01	$0.31	$2.17	$9.33	$113.00
3/9/2010 AM	17:02:00	117.4	1.13	$0.14	$0.00	$0.20	$1.45	$6.22	$75.73
3/9/2010 PM	6:40:00	118.3	0.76	$0.09	$0.01	$0.35	$2.50	$10.75	$130.00
3/10/2010 AM	17:30:00	118.4	1	$0.13	$0.00	$0.17	$1.25	$5.37	$65.41
3/10/2010 PM	6:46:00	118.5	0.7	$0.09	$0.01	$0.32	$2.26	$9.71	$118.00
3/11/2010 AM	17:04:00	117.1	1.39	$0.18	$0.01	$0.25	$1.78	$7.63	$92.95
3/11/2010 PM	7:08:00	118	0.73	$0.09	$0.01	$0.32	$2.24	$9.62	$117.00
3/12/2010 AM	16:55:00	118.4	1.35	$0.17	$0.01	$0.24	$1.73	$7.45	$90.65
3/12/2010 PM	7:07:00	118.1	0.68	$0.08	$0.01	$0.30	$2.11	$9.05	$110.00
3/15/2010 AM	64:08:00	118	2.71	$0.35	$0.00	$0.13	$0.92	$3.96	$48.19
3/15/2010 PM	6:38:00	117.4	0.63	$0.08	$0.01	$0.29	$2.09	$8.96	$109.00
3/16/2010 AM	16:59:00	117.9	0.75	$0.09	$0.00	$0.13	$0.96	$4.15	$50.49
3/16/2010 PM	6:50:00	117.9	0.78	$0.10	$0.01	$0.36	$2.53	$10.84	$131.00
3/17/2010 AM	17:26:00	116.4	1.4	$0.18	$0.01	$0.25	$1.76	$7.54	$91.80
3/17/2010 PM	7:37:00	117.8	0.98	$0.12	$0.01	$0.40	$2.81	$12.07	$146.00
3/18/2010 AM	16:09:00	117.1	1.33	$0.17	$0.01	$0.25	$1.80	$7.73	$94.09
3/18/2010 PM	6:57:00	118.4	0.74	$0.10	$0.01	$0.33	$2.36	$10.62	$127.45
3/19/2010 AM	17:29:00	117.6	1.41	$0.18	$0.01	$0.25	$1.76	$7.54	$91.80
3/19/2010 PM	6:40:00	118	0.6	$0.07	$0.01	$0.28	$1.98	$8.48	$103.00
Overall Average		117.8	1.16	$0.15	$0.01	$0.27	$1.95	$8.43	$102.19
Daytime Average		117.9	0.73	$0.09	$0.01	$0.33	$2.30	$9.94	$120.41
Overnight Average		117.6	1.62	$0.21	$0.01	$0.22	$1.58	$6.80	$82.68

DATE	Time Elapsed	Voltage	Total kWh	Total Cost	Cost/Hour	Cost/Day	Cost/Week	Cost/Month	Cost/Year
			BASELINE DATA FOR STATION 2						
3/1/2010 AM	NA	NA	NA	NA	NA	NA	NA	NA	NA
3/1/2010 PM	6:47:00	117.6	0.75	$0.09	$0.01	$0.34	$2.39	$10.28	$125.00
3/2/2010 AM	16:48:00	118.4	1.24	$0.16	$0.00	$0.22	$1.60	$6.88	$83.77
3/2/2010 PM	7:10:00	117.6	0.68	$0.08	$0.01	$0.29	$2.09	$8.96	$109.00
3/3/2010 AM	17:04:00	117.5	1.52	$0.19	$0.01	$0.27	$1.93	$8.30	$100.00
3/3/2010 PM	7:03:00	117.2	0.72	$0.09	$0.01	$0.32	$2.24	$9.62	$117.00
3/4/2010 AM	16:41:00	117.9	1.29	$0.16	$0.01	$0.24	$1.69	$7.26	$88.36
3/4/2010 PM	7:19:00	118.1	0.77	$0.10	$0.01	$0.33	$2.33	$9.99	$120.00
3/5/2010 AM	16:53:00	117.6	1.31	$0.17	$0.01	$0.24	$1.71	$7.35	$89.50
3/5/2010 PM	7:00:00	117.6	0.73	$0.10	$0.01	$0.33	$2.30	$10.33	$123.94
3/8/2010 AM	64:53:00	117.9	4.44	$0.58	$0.01	$0.21	$1.50	$6.76	$81.18
3/8/2010 PM	6:54:00	118.7	0.72	$0.09	$0.01	$0.31	$2.28	$9.80	$119.00
3/9/2010 AM	17:03:00	117.3	1.33	$0.17	$0.01	$0.24	$1.71	$7.35	$89.50
3/9/2010 PM	6:40:00	118.2	0.71	$0.09	$0.01	$0.33	$2.33	$9.99	$121.00
3/10/2010 AM	17:29:00	118.5	0.84	$0.11	$0.00	$0.16	$1.12	$4.81	$58.52
3/10/2010 PM	6:48:00	118.2	0.64	$0.08	$0.01	$0.29	$2.06	$8.86	$107.00
3/11/2010 AM	17:03:00	118.1	1.23	$0.16	$0.00	$0.22	$1.58	$6.79	$82.62
3/11/2010 PM	7:08:00	118	0.84	$0.11	$0.01	$0.37	$2.59	$11.12	$135.00
3/12/2010 AM	16:56:00	118.4	1.24	$0.16	$0.00	$0.22	$1.60	$6.88	$83.77
3/12/2010 PM	7:07:00	118.1	0.67	$0.08	$0.01	$0.29	$2.09	$8.96	$109.00
3/15/2010 AM	64:03:00	118.1	3.82	$0.50	$0.00	$0.18	$1.29	$5.56	$67.70
3/15/2010 PM	6:37:00	117.6	0.69	$0.09	$0.01	$0.33	$2.31	$9.90	$120.00
3/16/2010 AM	16:58:00	117.3	1.54	$0.20	$0.01	$0.28	$2.00	$8.58	$104.00
3/16/2010 PM	6:50:00	118.4	0.82	$0.10	$0.01	$0.37	$2.64	$11.31	$137.00
3/17/2010 AM	17:26:00	116.7	1.47	$0.19	$0.01	$0.26	$1.84	$7.92	$96.39
3/17/2010 PM	7:37:00	117.6	0.79	$0.10	$0.01	$0.32	$2.28	$9.80	$119.00
3/18/2010 AM	16:08:00	117.1	1.19	$0.15	$0.00	$0.23	$1.62	$6.97	$84.91
3/18/2010 PM	6:57:00	118.2	0.83	$0.11	$0.01	$0.38	$2.67	$12.05	$144.00
3/19/2010 AM	17:29:00	117.5	1.4	$0.18	$0.01	$0.25	$1.76	$7.54	$91.80
3/19/2010 PM	6:41:00	118.1	0.62	$0.07	$0.01	$0.28	$2.02	$8.67	$105.00
Overall Average		117.8	1.20	$0.15	$0.01	$0.28	$1.99	$8.57	$103.90
Daytime Average		117.9	0.73	$0.09	$0.01	$0.33	$2.31	$9.98	$120.73
Overnight Average		117.7	1.70	$0.22	$0.01	$0.23	$1.64	$7.07	$85.86

BASELINE DATA FOR STATION 3								
DATE	Time Elapsed	Voltage	Total kWh	Total Cost	Cost/Hour	Cost/Day	Cost/Week	Cost/Month	Cost/Year
3/1/2010 AM	NA	NA	NA	NA	NA	NA	NA	NA	NA
3/1/2010 PM	6:48:00	117.9	0.64	$0.08	$0.01	$0.29	$2.09	$8.96	$109.00
3/2/2010 AM	16:47:00	118.7	1.35	$0.17	$0.01	$0.25	$1.76	$7.54	$91.80
3/2/2010 PM	7:09:00	118	0.77	$0.10	$0.01	$0.33	$2.37	$10.18	$123.00
3/3/2010 AM	17:08:00	117.6	0.94	$0.12	$0.00	$0.17	$1.21	$5.18	$63.11
3/3/2010 PM	6:56:00	118	0.85	$0.11	$0.01	$0.38	$2.68	$11.50	$140.00
3/4/2010 AM	16:46:00	118.3	1.33	$0.17	$0.01	$0.24	$1.73	$7.45	$90.65
3/4/2010 PM	7:19:00	118.6	0.67	$0.08	$0.01	$0.28	$2.02	$8.67	$105.00
3/5/2010 AM	16:51:00	118.2	1.41	$0.18	$0.01	$0.26	$1.82	$7.82	$95.24
3/5/2010 PM	7:00:00	118.1	0.73	$0.10	$0.01	$0.33	$2.29	$10.31	$123.76
3/8/2010 AM	64:57:00	118.3	5.51	$0.72	$0.01	$0.27	$1.87	$8.40	$100.74
3/8/2010 PM	6:54:00	118.3	0.91	$0.11	$0.01	$0.41	$2.90	$12.45	$151.00
3/9/2010 AM	17:04:00	117.9	1.59	$0.20	$0.01	$0.29	$2.04	$8.77	$106.00
3/9/2010 PM	6:40:00	118.8	0.71	$0.09	$0.01	$0.33	$2.33	$9.99	$121.00
3/10/2010 AM	17:25:00	118.7	0.92	$0.12	$0.00	$0.17	$1.21	$5.18	$63.11
3/10/2010 PM	6:50:00	118.4	0.79	$0.10	$0.01	$0.36	$2.55	$10.94	$133.00
3/11/2010 AM	17:03:00	118.4	1.56	$0.20	$0.01	$0.28	$2.00	$8.58	$104.00
3/11/2010 PM	7:08:00	118.3	0.78	$0.10	$0.01	$0.34	$2.39	$10.28	$125.00
3/12/2010 AM	16:59:00	118.7	1.41	$0.18	$0.01	$0.26	$1.82	$7.82	$95.24
3/12/2010 PM	7:06:00	118.4	0.8	$0.10	$0.01	$0.35	$2.46	$10.56	$128.00
3/15/2010 AM	64:03:00	117.9	2.65	$0.34	$0.00	$0.12	$0.90	$3.86	$47.04
3/15/2010 PM	6:35:00	117.8	0.85	$0.11	$0.01	$0.40	$2.81	$12.07	$146.00
3/16/2010 AM	16:59:00	117.6	1.52	$0.19	$0.01	$0.27	$1.95	$8.39	$102.00
3/16/2010 PM	6:50:00	118.2	0.79	$0.10	$0.01	$0.36	$2.55	$10.94	$133.00
3/17/2010 AM	17:23:00	117.1	1.44	$0.18	$0.01	$0.26	$1.82	$7.82	$95.24
3/17/2010 PM	7:37:00	117.6	0.95	$0.12	$0.01	$0.38	$2.72	$11.69	$142.00
3/18/2010 AM	16:09:00	117.4	1.35	$0.17	$0.01	$0.26	$1.82	$7.82	$95.24
3/18/2010 PM	6:57:00	118.6	0.88	$0.11	$0.01	$0.39	$2.79	$11.97	$145.00
3/19/2010 AM	17:30:00	117.8	1.57	$0.20	$0.01	$0.28	$1.98	$8.48	$103.00
3/19/2010 PM	6:40:00	118.2	0.64	$0.08	$0.01	$0.30	$2.11	$9.05	$110.00
Overall Average		118.1	1.25	$0.16	$0.01	$0.30	$2.10	$9.06	$109.90
Daytime Average		118.2	0.78	$0.10	$0.01	$0.35	$2.47	$10.64	$128.98
Overnight Average		118.0	1.75	$0.22	$0.01	$0.24	$1.71	$7.37	$89.46

DATE	Time Elapsed	Voltage	Total kWh	Total Cost	Cost/Hour	Cost/Day	Cost/Week	Cost/Month	Cost/Year
STATION 1 DATA AFTER MESSAGE IMPLEMENTATION									
4/12/2010 AM	NA	NA	NA	NA	NA	NA	NA	NA	NA
4/12/2010 PM	6:51:00	117.4	0.64	$0.08	$0.01	$0.29	$2.04	$8.77	$106.00
4/13/2010 AM	16:56:00	117.1	1.43	$0.18	$0.01	$0.36	$1.84	$7.92	$96.39
4/13/2010 PM	7:01:00	117.5	0.78	$0.10	$0.01	$0.34	$2.44	$10.40	$127.00
4/14/2010 AM	17:03:00	116.8	1.33	$0.17	$0.01	$0.24	$1.71	$7.35	$89.50
4/14/2010 PM	7:14:00	117.5	0.75	$0.09	$0.01	$0.32	$2.28	$9.80	$119.00
4/15/2010 AM	16:43:00	117.2	0.42	$0.05	$0.00	$0.07	$0.55	$2.35	$28.68
4/15/2010 PM	7:07:00	118	0.64	0.08	0.01	0.27	1.95	8.39	102
4/16/2010 AM	17:12:00	117.7	1.32	$0.17	$0.01	$0.24	$1.69	$7.26	$88.36
4/16/2010 PM	7:00:00	117.6	0.77	$0.10	$0.01	$0.34	$2.42	$9.68	$116.16
4/19/2010 AM	71:40:00	117.1	3.88	$0.50	$0.00	$0.16	$1.18	$5.09	$61.96
4/19/2010 PM	6:52:00	117.7	0.75	$0.09	$0.01	$0.34	$2.39	$10.28	$125.00
4/20/2010 AM	17:06:00	117.4	1.57	$0.20	$0.01	$0.28	$2.02	$8.67	$105.00
4/20/2010 PM	7:14:00	117	0.92	$0.12	$0.01	$0.40	$2.81	$12.07	$146.00
4/21/2010 AM	16:51:00	116.8	1.07	$0.14	$0.00	$0.19	$1.38	$5.94	$72.29
4/21/2010 PM	6:41:00	117.7	0.76	$0.09	$0.01	$0.35	$2.50	$10.75	$130.00
4/22/2010 AM	17:09:00	117.2	1.51	$0.19	$0.01	$0.27	$1.91	$8.20	$99.83
4/22/2010 PM	6:58:00	116.4	0.81	$0.10	$0.01	$0.36	$2.55	$10.94	$133.00
4/23/2010 AM	17:16:00	116.8	0.93	0.12	$0.00	$0.16	$1.18	$5.09	$61.96
4/23/2010 PM	7:15:00	117.5	0.85	$0.11	$0.01	$0.36	$2.57	$11.03	$134.00
4/26/2010 AM	64:34:00	116.4	5.77	$0.75	$0.01	$0.27	$1.95	$8.39	$102.00
4/26/2010 PM	6:48:00	117.5	0.87	$0.11	$0.01	$0.40	$2.83	$12.16	$148.00
4/27/2010 AM	17:11:00	116.1	2.16	$0.28	$0.01	$0.39	$2.75	$11.79	$143.00
4/27/2010 PM	7:06:00	117.4	1.02	$0.13	$0.01	$0.45	$3.16	$13.58	$165.00
4/28/2010 AM	16:52:00	116.3	0.98	$0.12	$0.00	$0.18	$1.27	$5.47	$66.55
4/28/2010 PM	6:59:00	117.5	0.92	$0.12	$0.01	$0.41	$2.90	$12.45	$151.00
4/29/2010 AM	16:52:00	117.1	2.06	$0.26	$0.01	$0.38	$2.68	$11.50	$140.00
4/29/2010 PM	6:45:00	118	0.87	$0.11	$0.01	$0.40	$2.81	$12.07	$146.00
4/30/2010 AM	16:58:00	117	0.15	$0.01	$0.00	$0.02	$0.19	$0.84	$10.32
4/30/2010 PM	6:58:00	117.7	0.68	$0.08	$0.01	$0.30	$2.15	$9.24	$112.00
Overall Average		117.2	1.26	$0.16	$0.01	$0.29	$2.07	$8.88	$107.79
Daytime Average		117.5	0.80	$0.10	$0.01	$0.36	$2.52	$10.77	$130.68
Overnight Average		116.9	1.76	$0.22	$0.01	$0.23	$1.59	$6.85	$83.27

STATION 2 DATA AFTER MESSAGE IMPLEMENTATION									
DATE	Time Elapsed	Voltage	Total kWh	Total Cost	Cost/Hour	Cost/Day	Cost/Week	Cost/Month	Cost/Year
4/12/2010 AM	NA	NA	NA	NA	NA	NA	NA	NA	NA
4/12/2010 PM	6:52:00	117.7	0.71	$0.09	$0.01	$0.32	$2.28	$9.80	$119.00
4/13/2010 AM	16:57:00	117.5	0.49	$0.06	$0.00	$0.09	$0.63	$2.73	$33.27
4/13/2010 PM	7:01:00	117.9	0.67	$0.08	$0.01	$0.30	$2.11	$9.05	$110.00
4/14/2010 AM	17:03:00	117.2	0.23	$0.03	$0.00	$0.04	$0.28	$1.22	$14.91
4/14/2010 PM	7:14:00	117.7	0.42	$0.05	$0.00	$0.18	$1.27	$5.47	$66.55
4/15/2010 AM	16:42:00	117.2	0.83	$0.10	$0.00	$0.15	$1.07	$4.62	$56.23
4/15/2010 PM	7:07:00	118.4	0.75	$0.09	$0.01	$0.33	$2.31	$9.90	$120.00
4/16/2010 AM	17:13:00	117.6	0.3	$0.03	$0.00	$0.05	$0.37	$1.60	$19.50
4/16/2010 PM	7:00:00	117.8	0.67	$0.08	$0.01	$0.30	$2.11	$8.43	$101.11
4/19/2010 AM	71:39:00	116.9	0.86	$0.11	$0.00	$0.03	$0.26	$1.13	$13.77
4/19/2010 PM	6:52:00	118.2	0.61	$0.07	$0.01	$0.27	$1.95	$8.39	$102.00
4/20/2010 AM	17:07:00	117.6	0.45	$0.05	$0.00	$0.08	$0.57	$2.45	$29.83
4/20/2010 PM	7:13:00	117.6	0.83	$0.10	$0.01	$0.36	$2.53	$10.84	$131.00
4/21/2010 AM	16:52:00	117.3	0.33	$0.04	$0.00	$0.06	$0.44	$1.88	$22.95
4/21/2010 PM	6:41:00	118.1	0.56	$0.07	$0.01	$0.26	$1.87	$8.01	$97.54
4/22/2010 AM	17:09:00	117.3	0.52	$0.06	$0.00	$0.09	$0.66	$2.82	$34.42
4/22/2010 PM	6:59:00	116.8	0.4	$0.05	$0.00	$0.17	$1.25	$5.37	$65.41
4/23/2010 AM	17:13:00	117.1	0.39	$0.05	$0.00	$0.06	$0.48	$2.07	$25.24
4/23/2010 PM	7:17:00	117.9	0.65	$0.08	$0.01	$0.28	$1.98	$8.48	$103.00
4/26/2010 AM	64:32:00	116.8	0.69	$0.09	$0.00	$0.03	$0.22	$0.94	$11.47
4/26/2010 PM	6:49:00	118.1	0.79	$0.10	$0.01	$0.36	$2.55	$10.94	$133.00
4/27/2010 AM	17:10:00	116.1	0.69	$0.09	$0.00	$0.12	$0.88	$3.77	$45.90
4/27/2010 PM	7:07:00	117.6	0.93	$0.12	$0.01	$0.40	$2.86	$12.26	$149.00
4/28/2010 AM	16:51:00	116.8	1.13	$0.14	$0.00	$0.21	$1.47	$6.31	$76.88
4/28/2010 PM	6:59:00	117.6	0.85	$0.11	$0.01	$0.38	$2.68	$11.50	$140.00
4/29/2010 AM	16:52:00	117.1	0.67	$0.08	$0.00	$0.12	$0.85	$3.67	$44.75
4/29/2010 PM	6:45:00	117.9	0.88	$0.11	$0.01	$0.40	$2.86	$12.26	$149.00
4/30/2010 AM	16:58:00	117.1	1.33	$0.17	$0.01	$0.24	$1.71	$7.35	$89.50
4/30/2010 PM	6:59:00	118.1	0.68	$0.08	$0.01	$0.30	$2.15	$9.24	$112.00
Overall Average		117.5	0.67	$0.08	$0.00	$0.21	$1.47	$6.29	$76.46
Daytime Average		117.8	0.69	$0.09	$0.01	$0.31	$2.18	$9.33	$113.24
Overnight Average		117.1	0.64	$0.08	$0.00	$0.10	$0.71	$3.04	$37.04

STATION 3 DATA AFTER MESSAGE IMPLEMENTATION									
DATE	Time Elapsed	Voltage	Total kWh	Total Cost	Cost/Hour	Cost/Day	Cost/Week	Cost/Month	Cost/Year
4/12/2010 AM	NA	NA	NA	NA	NA	NA	NA	NA	NA
4/12/2010 PM	6:52:00	118.2	0.69	$0.09	$0.01	$0.31	$2.22	$9.52	$115.00
4/13/2010 AM	16:59:00	117.6	1.53	$0.20	$0.01	$0.28	$1.98	$8.48	$103.00
4/13/2010 PM	7:00:00	118	0.62	$0.08	$0.01	$0.27	$1.93	$8.30	$100.00
4/14/2010 AM	17:03:00	117.5	1.41	$0.18	$0.01	$0.26	$1.82	$7.82	$95.24
4/14/2010 PM	7:14:00	118.2	0.5	$0.06	$0.00	$0.22	$1.54	$6.60	$80.84
4/15/2010 AM	16:44:00	117.9	1.09	$0.14	$0.00	$0.20	$1.43	$6.13	$74.59
4/15/2010 PM	7:08:00	118.7	0.97	$0.12	$0.01	$0.42	$2.99	$12.82	$156.00
4/16/2010 AM	17:14:00	117.9	2.11	$0.27	$0.01	$0.38	$2.68	$11.50	$140.00
4/16/2010 PM	7:00:00	117.6	0.62	$0.08	$0.01	$0.28	$1.95	$7.80	$93.57
4/19/2010 AM	71:39:00	117.5	4.35	$0.56	$0.00	$0.18	$1.32	$5.65	$68.85
4/19/2010 PM	6:52:00	118.4	0.93	$0.12	$0.01	$0.42	$2.99	$12.82	$156.00
4/20/2010 AM	17:08:00	118	1.85	$0.24	$0.01	$0.33	$2.37	$10.18	$123.00
4/20/2010 PM	7:13:00	117.8	1.01	$0.13	$0.01	$0.44	$3.08	$13.20	$160.00
4/21/2010 AM	16:51:00	117.2	1.74	$0.22	$0.01	$0.32	$2.26	$9.71	$118.00
4/21/2010 PM	6:41:00	118.2	0.86	$0.11	$0.01	$0.40	$2.83	$12.16	$148.00
4/22/2010 AM	17:09:00	117.6	1.68	$0.22	$0.01	$0.30	$2.15	$9.24	$112.00
4/22/2010 PM	7:00:00	117.2	0.93	$0.12	$0.01	$0.41	$2.92	$12.54	$152.00
4/23/2010 AM	17:11:00	117.4	1.78	$0.23	$0.01	$0.32	$2.28	$9.80	$119.00
4/23/2010 PM	7:18:00	118.4	0.45	$0.05	$0.00	$0.19	$1.34	$5.75	$70.00
4/26/2010 AM	64:33:00	117	0.34	$0.04	$0.00	$0.01	$0.11	$0.47	$5.73
4/26/2010 PM	6:49:00	118	1.01	$0.13	$0.01	$0.46	$3.27	$14.05	$170.00
4/27/2010 AM	17:10:00	116.7	1.94	$0.25	$0.01	$0.35	$2.46	$10.56	$128.00
4/27/2010 PM	7:07:00	118.2	0.34	$0.04	$0.00	$0.15	$1.07	$4.62	$56.23
4/28/2010 AM	16:52:00	117.4	0.06	$0.00	$0.00	$0.00	$0.06	$0.28	$3.44
4/28/2010 PM	6:59:00	118	1.03	$0.13	$0.01	$0.46	$3.23	$13.86	$168.00
4/29/2010 AM	16:52:00	117.8	1.84	$0.24	$0.01	$0.34	$2.39	$10.28	$125.00
4/29/2010 PM	6:45:00	118.3	0.82	$0.10	$0.01	$0.38	$2.66	$11.41	$138.00
4/30/2010 AM	16:58:00	117.9	0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
4/30/2010 PM	6:59:00	118.2	0.79	$0.10	$0.01	$0.40	$2.83	$12.16	$148.00
Overall Average		117.8	1.15	$0.15	$0.01	$0.29	$2.07	$8.89	$107.84
Daytime Average		118.1	0.77	$0.10	$0.01	$0.35	$2.46	$10.51	$127.44
Overnight Average		117.5	1.55	$0.20	$0.01	$0.23	$1.67	$7.15	$86.85