

Smart Power Strip Energy Savings Evaluation

Ross Complex, Vancouver, Wa

Intro

The goal of this project is to quantify the energy savings associated with the installation of current sensing-smart strips in office cubicles at BPA's Ross Complex located in Vancouver, Washington. The three buildings where the strips were installed included the Warehouse, the Warehouse Modular and the CSB. (See Attachment C). There are various kinds of power strips and current sensing smart strips were selected because they offer electrical energy savings increased safety. Office environments can increase safety by reducing fire hazards by turning off heaters when a workspace is unoccupied. Energy savings are achieved by turning off power to devices plugged into the strip, eliminating vampire loads. The smart power strips were provided to BPA by the Energy Trust of Oregon and the project results will be shared with them for developing similar programs offerings around smart power strips in office environments.

Project Testing Methods

Initially, current sensors were used on the existing power strips serving each cubicle, and baseline logging began around January 25th, 2011 with an initial logging period of three weeks ending on February 15th, 2011. Baseline data from the current sensors was downloaded at that time for a later spot check for accuracy. The facilities crew helping with the project replaced the existing power strips with smart power strips on February 15, 2011 and post-installation data acquisition began.

Analysis of the downloaded baseline data showed that the current sensors were not correctly sensing power use. Specifically, the data collected showed cycling of power in very small time increments of 2 to 3 seconds, which was not accurate. So, a new data logging methodology was developed to correctly quantify energy use for the project. The final method for getting baseline and post-installation energy use data used Kill-A-Watt EZ meters. The final test setup for the smart strips is shown in Figure 1 below.

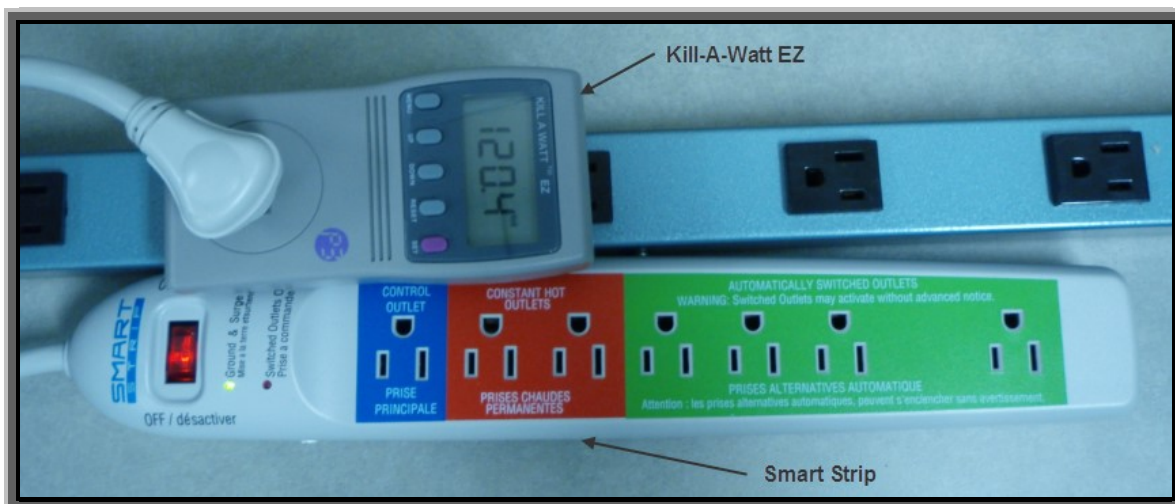


Figure 1

Once the new meters were installed, data collection began on April 14, 2011. Since the smart strips had already been installed at the three participating buildings it was decided that post-testing data collection would commence first, followed by reinstalling the original power strips before completing the baseline data collection.

On April 14th and 19th, 2011, plug loggers were installed and post-installation data collection began. Figure 2 shows guidelines for where to plug various loads into the type of equipment connected to the smart strip for this project.

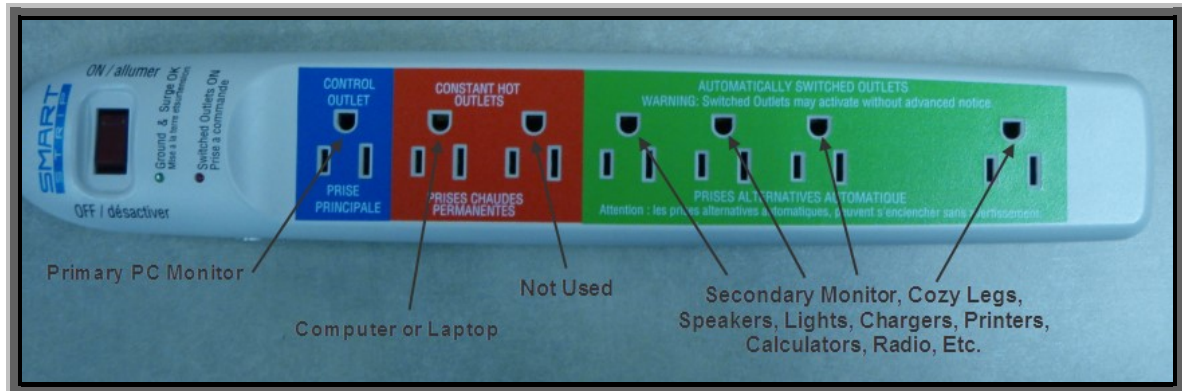


Figure 2

The blue outlet is the control node which determines when the green outlets cycle on and off. In all cases the primary computer monitor was plugged into the blue control outlet and when the computer monitor went into sleep mode (according to BPA IT department: after 10 minutes of no activity), anything plugged into the green outlets would cycle off. When the user returned to the cubicle and used the computer all the green outlets would cycle on. The computer CPU or laptop was plugged into the red constant hot (constant on) outlet to protect against data loss. For the exact connections at each cubicle refer to Attachment A.

The smart power strips have a potentiometer located along the left side of the device, refer to Figure 3. The proper position for the potentiometer was determined during pre deployment testing by plugging a monitor into the blue control outlet and cycling the power on and off to ensure that the green switched outlets powered on and off properly. The potentiometer sets the minimum power threshold at which the power is cycled off to the switched (green) outlets. Once the proper position for the potentiometer was found all smart power strips were set to the same position.

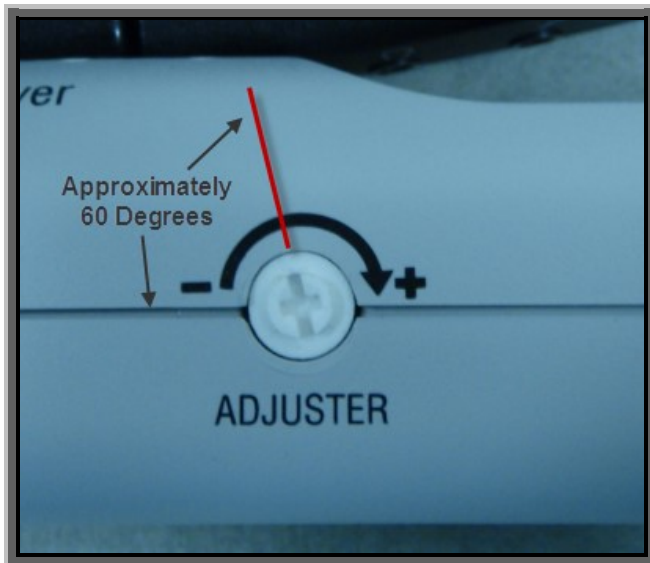


Figure 3

A Kill-A-Watt EZ meter was installed at each corresponding wall socket, and a smart strip was then plugged (as a load device) into the meter. Figure 4 shows an EZ meter.

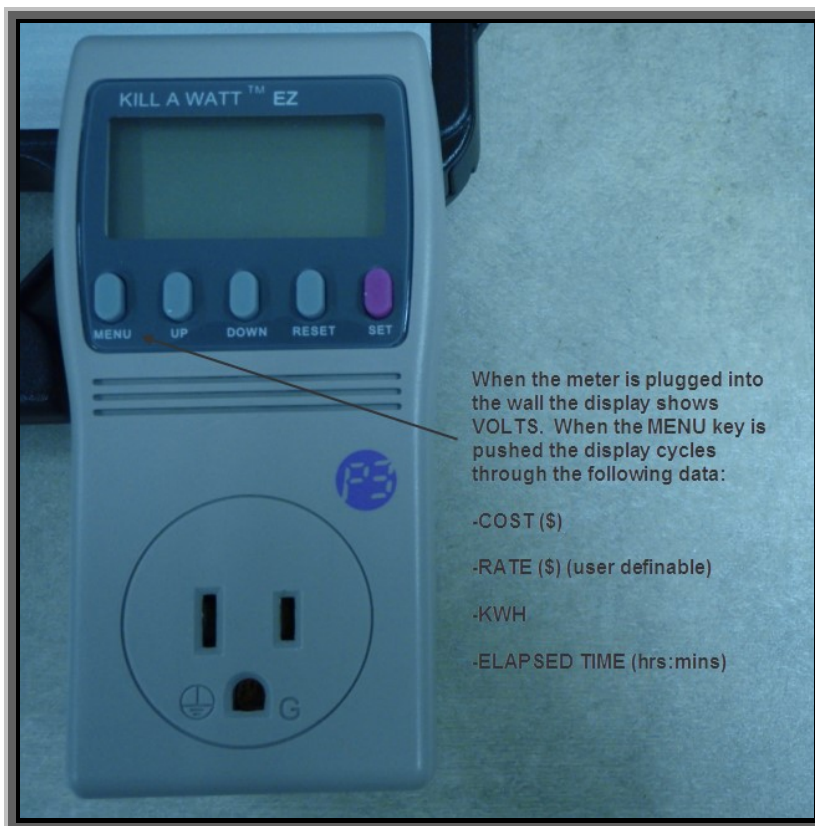


Figure 4

A default Kill-A-Watt electrical rate of \$0.045/kWh was used in the Kill-A-Watt meter setup, however since the purpose of this experiment was primarily to determine KWh savings the electrical rate was not used. (See Attachment A or Excel File named 'Ross Smartstrip Data.xls') One of the reasons the Kill-A-Watt EZ meter was selected was because it has a built in battery backup which allows the user to unplug the meter and

move it to another outlet without losing logged information. This becomes important during data collection because some of the outlet locations under cubicles make it very difficult to see the screen to record data. The battery backup allows the user to move the logger to a more easily accessed outlet without losing the accumulated data. Also, it should be noted that the Kill-A-Watt EZ is a totalizer, which means it totals instantaneous data to give a summation of the energy used in KWh, verses other logger types which allow users to define time intervals and download discrete energy values.

Over May 5th and 6th, 2011, the original power strips were reinstalled and the Kill-A-Watt EZ meters were read and reset, and the data recorded into the excel file. On May 21st, 26th and 27th, 2011, final readings were recorded for the baseline data and the Kill-A-Watt meters were removed and returned to BPA stock. This resulted in approximately 3 weeks of baseline and 3 weeks of post data collection.

Metering Summary & Recommendations

Recommendations for completing a project of this type include having adequate tools for installation and collection. During the project the following items were helpful during implementation: knee pads, flashlight, small flathead screwdriver, for modifying the potentiometer on the smart power strips and lastly depending on the number of strips and meters being installed, a large container, preferably with wheels, for transporting the smart strips and Kill-A-Watts around the facility. A garbage can with wheels was used for this project. Time to install the forty-eight Kill-A-Watt meters was approximately 6 hours.

Pre-testing the meter and smart strip configuration using similar equipment encountered in the field will allow the implementer to pre-set the potentiometer on the smart power strips ensuring proper on/off operation of the switched (green) plugs. It was found during this project that once the proper adjustment was found, all smart strips could be set similarly with less than 1% further adjustment in the field. Out of the forty-eight strips initially installed, the potentiometer had to be readjusted for two because when the monitor went into sleep mode the green power plugs did not turn off. When operating properly there is a light on the smart strip that visually indicates when the switched (green) plugs are active. See Figure 5.



Figure 5

Project Results

Attachment A shows the data collected for both baseline and post-installation data collection which will be discussed in this section. The data calculations were used to determine if installing smart strips saved any energy. See Table 1 below for energy savings results.

BPA-Ross Complex Smart Strip Project									
Location (See DWGS)	Control Plug	Hot Plugs	Switchable Plugs	Baseline Data (KWH)	Baseline/Post Metering interval	Post Meter Data (KWH)	Kwh Change Per Cube	Hourly KW savings per cube	Yearly KWh savings Per Cube
1 monitor	pc		cozy legs, printer, radio, picture frame			Removed due to access issues			
2 monitor	pc		monitor, speaker, phone charger	23.29	504	21.47	1.82	0.0036	31.6333
3 monitor	pc		monitor, cozy legs	23.85	504	26.66	-2.81	-0.0056	-48.8405
51 monitor	pc		monitor, cozy legs, printer, light			User rearranged what was plugged into smart power strip			
9 monitor	pc		monitor, lifter, overhead light	32.25	504	28.43	3.82	0.0076	66.3952
10 monitor	pc		monitor, label printer, cozy toes, light			Defective smart power strip			
11 monitor	pc		cozy legs, printer, radio, shredder	67.25	504	6.41	60.84	0.1207	1057.4571
12 monitor	pc		monitor, cozy legs, speakers	16.02	504	13.69	2.33	0.0046	40.4978
13 monitor	pc		light, speakers, phone charger	21.07	504	19.13	1.94	0.0038	33.7190
14 monitor	pc		monitor, 2 lights	8.49	504	7.93	0.56	0.0011	9.7333
15 monitor	pc		monitor, light, speakers	19.55	385	18.28	1.27	0.0033	28.8966
16 monitor	pc		monitor, speakers 2 lights	23.38	385	23.24	0.14	0.0004	3.1855
17 monitor	pc		monitor, cozy legs, speakers, light	20.65	385	18.06	2.59	0.0067	58.9309
18 monitor	pc		monitor, cozy legs, speakers	21.68	385	12.81	8.87	0.0230	201.8213
19 monitor	pc		monitor, 2 lights, speakers	20.81	385	17.14	3.67	0.0095	83.5044
20 monitor	pc		monitor, 2 lights	19.71	385	18.54	1.17	0.0030	26.6213
21 monitor	pc		monitor			Removed due to defective logger			
23 monitor	pc		speakers, cozy legs	12.2	385	9.07	3.13	0.0081	71.2177
26 monitor	pc		monitor, light			User removed smart power strip			
28 monitor	pc		monitor, heater, phone charger	23.68	385	9.40	14.28	0.0371	324.9164
29 monitor	pc		monitor, speakers, light	40.25	385	29.43	10.82	0.0281	246.1901
30 monitor	pc		monitor, speakers, light	26.28	385	22.57	3.71	0.0096	84.4145
31 monitor	pc		fan, 2 lamps, stapler	25.88	385	23.07	2.81	0.0073	63.9366
32 monitor	pc			38.48	385	23.54	14.94	0.0388	339.9335
33 monitor	pc		speakers, 2 lamps	29.1	385	24.11	4.99	0.0130	113.5387
34 monitor	pc		speakers, 2 lamps	12.94	506	13.27	-0.33	-0.0007	-5.7130
35 monitor	pc		monitor, 2 lights	26.7	530	13.30	13.40	0.0253	221.4792
36 monitor	pc		monitor, fan, pencil sharpener	32.44	530	21.95	10.49	0.0198	173.3819
37 monitor	pc		cozy legs, pencil sharpener, speakers, 2 light	21.013	506	14.44	6.57	0.0130	113.7934
39 monitor	pc		monitor, 2 lights	23.75	530	10.39	13.36	0.0252	220.8181
40 monitor	pc		monitor, 2 lights, speakers			User removed smart power strip			
42 monitor	pc		speakers	12.37	506	1.19	11.18	0.0221	193.5510
43 monitor	pc		lamp, speakers, pencil sharpener	31.18	506	13.98	17.20	0.0340	297.7708
44 monitor	pc		speakers, 2 lights	20.18	506	7.05	13.13	0.0259	227.3099
45 monitor	pc		pencil sharpener, stapler, lamp, desk lifter	14.23	530	11.10	3.13	0.0059	51.7336
46 monitor	pc		speakers	31.96	506	14.88	17.08	0.0338	295.6933
47 monitor	pc		monitor, speakers	21.12	530	11.43	9.69	0.0183	160.1592
48 monitor	pc		2 lamps, scanner			User passed away family removed smart power strip			
49 monitor	pc		monitor, 2 lights, radio	32.44	530	10.53	21.91	0.0413	362.1351
50 monitor	pc		fan, cozy legs, 2 lights	9.31	506	10.52	-1.21	-0.0024	-20.9478
52 monitor	pc		2 lights, speakers	9.42	506	8.01	1.41	0.0028	24.4103
53 monitor	pc		laptop	27.39	530	22.52	4.87	0.0092	80.4928
54 monitor	pc		scanner, light, calculator	14.66	530	11.22	3.44	0.0065	56.8574
55 monitor	pc		2 lights	13.18	506	11.81	1.37	0.0027	23.7178
56 monitor	pc		speakers	39.56	530	31.56	8.00	0.0151	132.2264
57 monitor	pc		speakers, lamp, charger	20.29	530	6.14	14.15	0.0267	233.8755
58 monitor	pc		speakers, calculator	25.34	530	19.28	6.06	0.0114	100.1615
59 monitor	pc		2 lights, speakers	54.35	530	44.08	10.27	0.0194	169.7457
Cubicles with Cozy Legs (Heaters)						Summations	326.06	0.6793	5967.5619
						Averages	7.95		145.5503

Table 1

As the above data shows the total yearly energy savings for the 41 cubicles was **5967 KWh** with an average savings per cubicle equal to **145 KWh**.

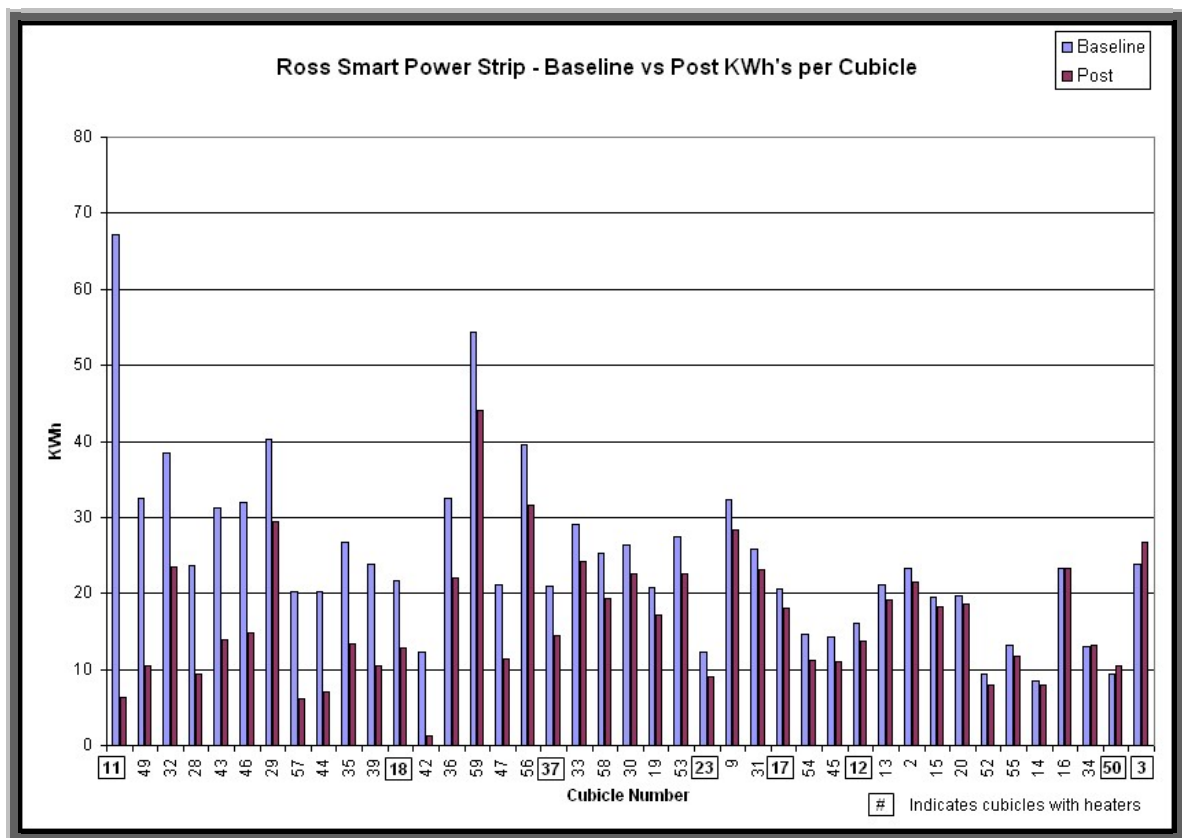


Figure 6

As the above graph shows smart power strips resulted in varying degrees of energy savings when installed. One reason for this variation is due to the change in the outside air temperature. In the month of April during post testing the average outside air temperature was 61.4 degrees, however in May during baseline testing the average outside air temperature was 67.4 degrees. The increase in air temperature caused the heaters to run less during the baseline verses post data collection. Table 2 shows the average outside air temperature for the Vancouver, WA area.

Month	Average Max Temp (F)	Average Min Temp (F)	Average Total Precipitation (in.)	Average Total Snowfall (in.)
Jan	44.6	32.4	5.74	4.0
Feb	49.7	34.4	4.51	1.4
Mar	55.3	37.4	3.78	0.3
Apr	61.4	40.7	2.68	0.0
May	67.4	45.6	2.21	0.0
Jun	72.7	50.5	1.66	0.0

Table 2-Average Outdoor Temperatures for Vancouver, WA during 2011

When the eight cubicles with heaters are removed from the project the savings per cubicle drops to an average of **7.54 KWh**. This makes sense considering that the highest load device connected to the green switched plugs has been eliminated. (See Attachment

D for the calculations with the heaters removed.) When the heaters are operating they use 160 Watt-hrs of energy for every hour of operation.

Originally, forty-eight smart strips were installed; seven cubicles (14.6%) were not included in the project savings. The following table summarizes the reasons.

Cubicle #	Reason for removal from project
1	Access issues, supervisor's office always locked
10	Defective smart strip
21	Defective Kill-A-Watt EZ
26	User removed strip-complained about operation
40	User removed strip-complained about operation
48	User passed away-family removed strip with personal property
51	User rearranged what was plugged in between post and baseline logging

Overall, people who had the smart strips installed in their workspaces had very few complaints. The two users who removed the strips said they didn't like the fact that task lights in their cubicles turned off when they left the cubicle and didn't turn back on until they activated their computer. However, once the computer was activated it only took 2 seconds for the green outlets to power on. Most users noticed no negative impacts and liked the fact that they were not wasting energy when they were away from their work areas. Some people said they really liked the fact that if they forgot to turn something off at the end of the day the smart power strip would turn it off for them.

Program Considerations

As of the writing of this report smart strips are included in BPA's implementation manual as an RTF provisionally deemed program offering through September 2011. In order to ensure energy savings for smart power strips it is recommended that installation guidelines and minimum wattage requirements be developed. This could include tracking the various devices connected to the smart power strips and comparing it to minimum program wattage requirements.

Currently, the RTF provisionally deemed energy savings are 100 KWh per year for smart power strips. Figure 7 below shows approximately 60% of the cubicles are within 20% of this value. If only a computer and monitor are used, a better option would be to use the software option in the BPA Implementation manual called "Network Computer Power Management."

Installation time for smart power strips in offices for this project was 6 hours. To install meters and collect data, both baseline and post, was an additional 16 hours.

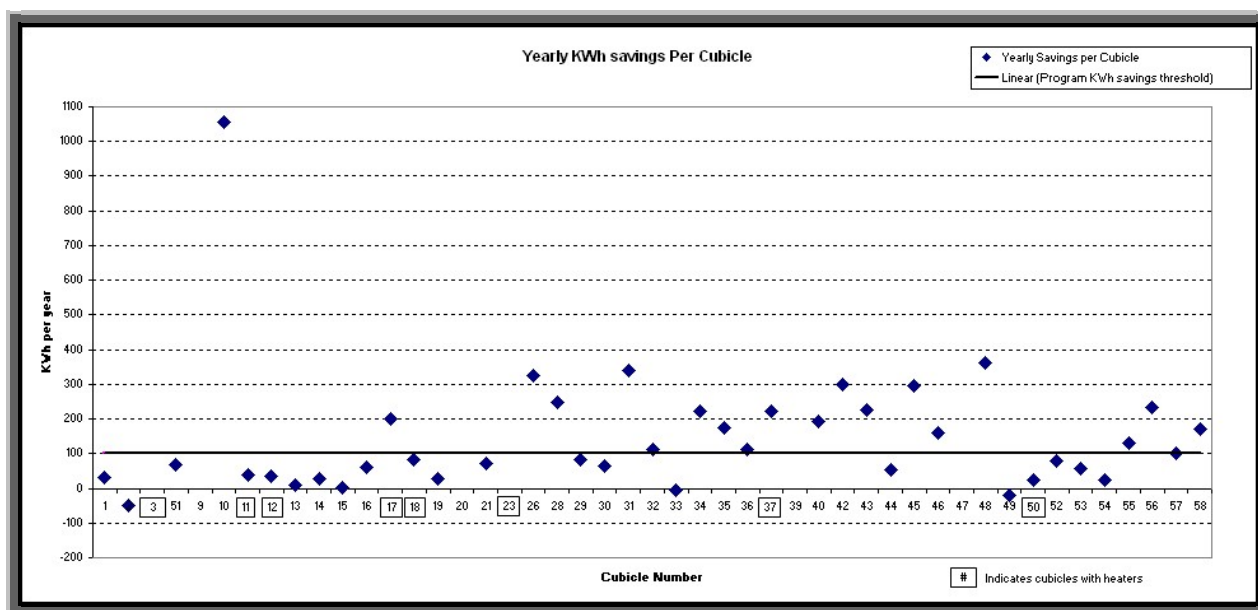


Figure 7

Conclusions

Although this is a small study using current sensing smart strips, the average yearly energy savings of 145 KWh per cubicle shows that the RTF provisionally deemed value of 100 KWh per year is conservative. Smart power strips save energy; they also improve safety by turning off potential fire sources (i.e. heaters) and reduce vampire loads.

Overall savings would have been higher if the outside air temperature between baseline and post testing was consistent. Refer to Table 2 above. The higher outside air temperature during post testing resulted in the heaters running less often which lowered the overall energy savings. Care should be taken in future testing of this type to ensure that the outside air temperature is as consistent as possible between the testing time frames.

Currently another energy savings project around smart power strips is underway at the department of the Navy. This project is being implemented by BPA's Energy Efficiency department personnel, Jim Borthen and Michael Huber. The smart power strips being deployed for this project use an occupancy sensor to turn the power off and on to the strip instead of a potentiometer that shuts off power to the plugs on a drop in power level. An energy savings and operational comparison between this project and the Navy project should be completed to see if there is any advantage between the two types of smart power strips.