

Going Green with IT: A Study of Energy Consumption by Home and School Information Technology Systems in the College of Information at the University of North Texas

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ABSTRACT

This paper addresses the strategies introduced by the College of Information at the University of North Texas to monitor and begin implementing approaches to enable the college to move toward the university's strategic goal of becoming a climate-neutral, "Green University" [3]. Data based on monitoring selected office and home inventories of information technology equipment were used to generate estimated production-level use and standby (vampire) consumption of electrical energy. Sample-based estimations and projections regarding 2008 to 2009 progress indicate that the College of Information at the University of North Texas has made extensive progress over one year in reducing the energy consumed by its information technology systems. New computer and printer systems have greater processing power and capabilities but consume no more power than the ones they replace, when in full operation. The computer systems consume one-half to one-third (and in some cases one-seventh) the power of the previous systems when in 'sleep', 'hibernate' or 'shut down' states that qualify for the standard definition of consuming stand by power. The authors estimate that these actions have brought the college at least halfway toward its five-year goal of becoming climate neutral, during the first year of the initiative.

Subject Descriptors

IT infrastructure, sustainability

General Terms

Management, measurement

Keywords

Energy consumption, standby power, going green

1. INTRODUCTION

One area of interest featured in the iConference Call for Participation is *IT infrastructure development and sustainability*

in the home, organizations, communities, and society. This area is consistent with the five-year strategic plan of the University of North Texas (UNT) to become a "Green University": "In April, 2008, UNT became the first major Texas public university to sign the American College & University Presidents Climate Commitment with an ultimate goal of becoming climate neutral" [3]. The College of Information within the University of North Texas receives support from the administration of the university for creating a sustainable office/home infrastructure for IT.

During the summer and fall of 2009, the College of Information (COI) at UNT began to develop and implement approaches to enable the college (and by implication, the entire university) to make significant strides toward the strategic goal. Data based on monitoring selected office and home inventories of information technology (IT) equipment are multiplied by known numbers of systems to generate estimated production-level use and standby (vampire) consumption of electrical energy. Projections are made regarding the progress that has been made over the 2008 to 2009 calendar year toward the "Green University" goal, and how much additional progress is still needed. Since energy monitoring equipment and protocols already exist within the college to support a National Science Foundation (NSF) funded project involving middle school students and their teachers, applications to university campus and home IT systems supporting the university mission have been straightforward. This paper focuses on reducing consumption in "intended use" applications as well as reducing electricity consumption in standby (vampire, wasted power) mode.

2. SIGNIFICANCE/RATIONALE

Global warming has resulted in an increase of about 1.3 degrees Fahrenheit in the annual average temperature of the earth between the beginning and end of the 20th Century [4]. The Intergovernmental Panel on Climate Change (IPCC) has concluded that most of the observed temperature increase since the middle of the 20th century was caused by increasing concentrations of greenhouse gases resulting from human activity such as fossil fuel burning and deforestation [4]. The global surface temperature will probably rise an additional 2.0 to 11.5 °F

during the twenty-first century if major steps to reduce greenhouse gas emissions are not put in place [4]. This will cause sea levels to rise, will expand subtropical deserts [5] will accelerate the retreat of glaciers, permafrost and sea ice; will increase the intensity of extreme weather events, will accelerate species extinctions, and will change agricultural yields.

Most scholars agree that electricity produced by burning coal is the most detrimental producer of greenhouse gas [1], because coal-fired plants produce 2.095 pounds of CO₂ for each kilowatt hour of electricity used by consumers [2]. Currently coal accounts for 57 percent of the electricity produced in the United States, so reducing the amount of electricity used is a straightforward means of reducing greenhouse gas emissions [6]. Many universities have taken on the task of reducing their own consumption of electricity as part of the American College & University Presidents Climate Commitment. The University of North Texas is one of those Universities. The College of Information at UNT seeks to be a role model for other colleges in the Going Green initiative at UNT.

3. ABOUT COI AT UNT

The College of Information at UNT has approximately 28 full-time faculty members spanning two departments. Three university research centers and several externally funded projects are also housed within the unit located in the former Texas Instruments manufacturing plant purchased by the University of North Texas and renamed Discovery Park. Much of the information technology equipment initially used by the college was brought by the two departments from their former homes in the Information Sciences and College of Education buildings on the university's main campus. However, significant funds were also made available for new purchases for the new facility.

4. FOUNDATION FOR STUDY IN NSF PROJECT: MIDDLE SCHOOLERS OUT TO SAVE THE WORLD

Beginning in October 2008, researchers in the Institute for the Integration of Technology into Teaching and Learning (IITTL), one of the three centers within the COI at UNT, received funding from the National Science Foundation to train middle school teachers to guide their students in monitoring standby power consumption (power consumed while no useful function is taking place) in household devices such as flat screen TVs, interactive game consoles, and portable power supplies for laptops and other information technology devices. Published estimates ranged from 5% to 20% [8] regarding the portion of electricity in the USA being wasted due to standby power load on the electrical grid, but no comprehensive study has been completed since 1999 [7]. Handheld monitoring devices for 14 classrooms in four US states were purchased, protocols were developed, and classroom teachers were brought together for training in June 2009. As teachers began using "Kill-A-Watt" and "Watts Up?" portable monitoring devices with their students during the fall of 2009, the suggestion was made at a COI faculty retreat that the same equipment and protocols could be applied to office and home IT devices, in order to monitor COI progress toward the UNT President's goal of becoming a Green University within five years of putting the new strategic plan for the university in place in 2008. Thus the current project was spawned.

5. COI PROGRESS DURING YEAR 1 OF THE FIVE YEAR PLAN

Many IT systems brought to the new college from their former faculty and staff locations for 2008-09 were replaced during the fall of 2009. Thus, an initial estimate of progress toward the goal of obtaining "Green University" status could be obtained by measuring normal "in use" energy consumed by old and new systems, as well as standby power consumed when the machines sat idle. These values could then be multiplied by the numbers of systems in use and the hours typically used in each state, resulting in an absolute estimate of kilowatt hours consumed as well as proportional reduction in load on the electrical grid, from old to new installations. This two-department, college-based estimate could then be extrapolated to the 58 departments in the 35,000 student university to obtain an estimate of the progress that could be made by moving to new, more energy efficient devices through the university. In a second phase of the study, recommendations regarding new energy saving devices and techniques with high potential return (such as unplugging all photocopiers during the 4 weeks the university is closed during Christmas break) could be produced. For phase 1, selected initial estimations of savings are listed below.

5.1 Office Computer Systems

Microsoft Windows operating system-based units are the officially supported information technology workstations at the University of North Texas, and therefore most systems used by faculty and staff are of this type. As of fall 2008, Windows tower computers manufactured by UNT's Microcomputer Maintenance Shop with a 15-17 inch CRT monitor, formed the typical workstation. As of 2009, most systems have been replaced by Dell Optiplex 950 computers with Dell AX510PA 17 inch flat panel LCD monitors.

As shown in Table 1, the 90 new Windows systems in the College of Information at UNT consume on average about one-fourth to one-third less power when in full use or screen-saver mode, versus the systems they replaced, and two-thirds to three-fourths less power when put to sleep or shut down. The Dell system power consumption when shut down (1.9 Watts) can be further decomposed into 1.2 watts for the computer and .7 watts for the attached monitor, which means both devices are near to complying with the latest Energy Star guidelines of "less than 1 watt" of standby power consumed, and in fact the monitor does comply. However, if the more typical definition of "being put to sleep", which allows "instant on" is taken as the standby power criterion, then the monitor still complies by virtue of consuming 1.0 watt of the 3.7 shown, but the computer itself still has a ways to go as it consumes 2.7 watts when put to sleep. The 90 new units are estimated to save more than 1150 pounds of CO₂ not put into the atmosphere each year by the extra power that would have had to be produced by the coal-burning plants that provide most of the Dallas-Ft. Worth Metroplex electricity (at 2.095 pounds of CO₂ per kilowatt hour). The cost savings to the university is approximately \$555 per year in reduced electrical cost, for 4625 fewer kilowatt hours used, based on an estimated nationwide current average price of \$.12 per kilowatt hour for electricity.

Table 1. Comparison of 2008 versus 2009 Typical Windows Office Workstation in College of Information at UNT.

| System | In Use | Screen Saver | Sleep Mode | Shut Down | Total |
|---------------------------------------|--------|--------------|------------|-----------|---------|
| 2008 Windows + CRT Monitor | 117.2 | 165 | 9.3 | 8.2 | |
| 2009 Windows + Flat Panel LCD Monitor | 91.7 | 92.5 | 3.7 | 1.9 | |
| Difference | 25.5 | 72.5 | 5.6 | 6.3 | |
| Hrs. per Day | 6.0 | 2.0 | 4.0 | 12.0 | |
| Days per wk | 5.0 | 5.0 | 5.0 | 2.0 | |
| Wks per yr | 30.0 | 30.0 | 30.0 | 22.0 | |
| KWH/Year | 23.0 | 21.8 | 3.4 | 3.3 | 51.5 |
| \$/KWH | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| \$/Unit/Yr | 2.8 | 2.6 | 0.4 | 0.4 | 6.2 |
| COI Units | 90.0 | 90.0 | 90.0 | 90.0 | 90.0 |
| Cum KWH/yr | 2065.5 | 1957.5 | 302.4 | 299.4 | 4624.8 |
| Cum \$/year | | | | | \$555.0 |
| LB CO2/Yr | | | | | 1162.7 |

In addition to the Windows workstations listed in Table 1, during 2009 the college purchased nine 21-inch flat panel iMac computers that are all-in-one units. These were placed in offices and labs in main departmental areas and are considered equal in processing power to the Dell Optiplex computers previously described. Each of these uses an average of 113.5 watts when turned on and in use, just slightly less than the Dell/Windows workstations listed in Table 1 (117.2 watts). However in screensaver mode the iMac uses considerably less (110 watts vs. 165 for Dell), while in sleep mode (1.7 watts) and when shut down (1.0 watts) they use much less than the 9.3 and 8.2 watts for the Dell systems. The iMacs appear to comply with the newest Energy Star guidelines for standby power in electronic appliances (< 1 watt in standby mode) and could be one avenue pursued by the University to reach its Going Green goals. Note that these machines typically replaced 15-inch eMac self-contained Apple computers that used built-in CRT screens. These eMac machines consumed 91.4 watts when in use, 7.7 watts when in sleep mode and 3.2 watts when shut down. As shown in Table 2, when in sleep mode or shut down, the iMacs use only 1/3 the power of the machines they replaced. The new iMacs consume roughly one-half the power of their Dell peers in the sleep or shutdown modes.

Table 2: Comparison of Self-Contained eMac Computers versus iMac Computers in College of Information at UNT

| System | In Use | Sleep Mode | Shut Down |
|--------|-------------|------------|-----------|
| eMac | 91.4 watts | 7.7 watts | 3.2 watts |
| iMac | 117.2 watts | 1.7 watts | 1.0 watts |

Color printers were also upgraded in the UNT College of Information during 2009. As of fall, 2009, the college housed eight, workgroup class, networked printers. These Dell Phaser 8860 color laser printers use approximately 162 watts when in operation and 11.5 watts in sleep (power saver) mode. This usage is much less than the 860 watts in full operation and 31.6 watts consumed in power saver mode by the HP Color Laser 4600 printers many of the Dell printers replaced. The new laser printers use only 1/3 as much electricity as the old.

5.2 Home-Based IT Systems

Ten faculty and staff in the College of Information at UNT took the “Watts Up?” energy monitoring devices home during September – October 2009 in order to provide data on their home IT systems used to support work functions. The number of reported plug-in appliances per home varied from two to twelve, with a computer and printer forming the minimal home configuration. Selected examples of old versus new systems for home computers and printers will be supplied for the purposes of providing an estimate of progress underway (and possible in the future) for IT used in the home.

One faculty member reported upgrading a computer and color printer during the 2008-09 time frame. A 15-inch Apple EMac (91.4 watts in operation, 7.7 watts in sleep mode, 3.2 watts shut down) was replaced by a 19-inch flat panel iMac (93.5 watts in use, 0 watts in sleep mode, 0 watts shut down). An HP 4430 Color Laser Printer (860 watts in operation, 31.6 watts in power saver, 0.2 watts switched off) was replaced by a Dell 2135 Color Laser Printer (90.5 watts in operation, 14.5 watts in hibernate mode, 0 watts switched off). The old computer used three to seven times more power than the new in sleep/shut down mode, while the old printer used twice as much power in power saver/hibernate mode. One unexpected revelation was that apparently all new Apple laptops with break-away power supply cables power down to 0 watts used in sleep mode (and shut down mode) after the battery is charged. Some newer Windows laptops were found to have this feature as well, such as a Toshiba 15” laptop tested by one home user. Apparently the power “bricks” themselves are smart enough to power down when the current drain drops to a small amount of the initial load.

5.3 One Area with Little Progress

Many IT workstations within the College of Information at UNT have universal power supply (UPS) battery backup systems to help prevent loss of data in the event of power loss. The standard unit provided at UNT consumes approximately 20.5 watts continuously even after the battery is charged, and even if the workstation is unplugged. Certainly hundreds of these must exist among the computers used by the 1830 faculty / staff on campus.

A UPS that powers itself down, similar to the power bricks on newer laptops, would make a great step forward toward energy conservation in this area.

6. SUMMARY/CONCLUSIONS

Data gathered during the summer and fall of 2009 indicate that the College of Information at the University of North Texas has made great progress from 2008 to 2009 in reducing the energy consumed by its information technology systems. New computer and printer systems have greater processing power and capabilities but consume no more power than the ones they replace, when in full operation. They consume one-half to one-third (and in some cases one-seventh) the power of the previous systems when in 'sleep' or 'hibernate' or 'shut down' states that qualify for the standard definition of consuming stand by power. For some devices, such as universal power supply battery backup systems, little progress has been made. However, overall we can conclude that the types of replacement equipment purchased in the College of Information over the past year, if applied through the entire university, would bring UNT at least halfway toward its five year goal of being a "Green University" in the area of IT systems.

7. ACKNOWLEDGMENTS

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8. REFERENCES

- [1] Borenstein, S. 2007. *Carbon-emissions culprit? Coal*. The Seattle Times Company. DOI=http://seattletimes.nwsources.com/html/nationworld/2003732690_carbon03.html
- [2] Department of Energy. 2000. *Carbon Dioxide Emissions from the Generation of Electric Power in the United States*. DOI=<http://tonto.eia.doe.gov/FTP/ROOT/environment/co2emissions00.pdf>.
- [3] Himmel, J. 2009. University of North Texas. DOI=<http://www.wimba.com/company/events/dls/#dls-archived>
- [4] IPCC (2007-05-04). *Summary for Policymakers* (PDF). Climate change 2007: The physical science basis. Contribution of working group I to the fourth assessment Report of the Intergovernmental Panel on Climate Change. DOI=http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_SPM.pdf
- [5] Lu, J., Vecchi, G. A.; Reichler, T. 2007. Expansion of the Hadley cell under global warming. *Geophysical Research Letters* **34**: L06805. doi:10.1029/2006GL028443. http://www.atmos.berkeley.edu/~jchiang/Class/Spr07/Gog257/Week10/Lu_Hadley06.pdf.
- [6] Power Scorecard. 2000. *Electricity from: Coal*. Pace University. DOI=http://www.powerscorecard.org/tech_detail.cfm?resource_id=2. White Plains, NY.
- [7] Rosen, K. B., & Meier A. K. 2000. *National energy use of set-top boxes and telephony products*. Berkeley, CA: Lawrence Berkeley National Laboratory.
- [8] Ross, J.P., & Meier, A. 2000. In Proceedings of the Second International Conference on Energy Efficiency in Household Appliances, Naples, Italy.
- [9] The American College & University Presidents' Climate Commitment. 2008. *Climate Leadership for America: Progress and Opportunities in Addressing the Defining Challenge of Our Time*. DOI=http://www2.presidentsclimatecommitment.org/reporting/documents/ACUPCC_AnnRep_2008.pdf

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