**Optimising power in a power hungry environment**
**Faculty of Medicine and Health Sciences Computer Users Area**

**GGHH Agenda Goals**

- Energy

**Faculty Goal**

- To maximise energy efficiency (lighting, heat pumps, water pumps, new buildings), reduce energy use (education, cut off times for certain energy consumption methods, reduce temperature requirements for geysers and air con) and introduce alternative energy sources (PV panels on roof, biogas, pressure flooring).

**Progress Achieved**

- Financial benefits (reduction in cost of electricity)
- Environmental benefit (reduction in energy consumption)

**The Issue**

Every Faculty at Stellenbosch University has a unique Computer Users Area (CUA). The function of these CUAs is to provide students with 24/7 access to computers and printers for study and research.

Figure 1: The computer user area at the Faculty of Medicine and Health Sciences.

These areas are power-hungry, not only the powering of the physical equipment, but the supporting infrastructure including networking, air conditioning, lighting and servers. With the

escalating costs of power provided by the parastatal, ESKOM, and the ever-present "load-shedding", (an energy utility's method of reducing demand on the energy generation system by temporarily switching off distribution of energy to different geographical areas) the faculty required an innovative system of reducing power without sacrificing computing power. The challenge was to:

- Provide 150 networked computers and 11 printers with power during load-shedding, especially during exams.
- Share the computers amongst an increasing number of students – currently around 2800.
- Work within a limited budget for purchasing new computers
- Reduce power consumption by 10% annually from the 1080kWh/day in 2009 to 450kWh/day in 2015

**Sustainability Strategy Implemented**

In brief the solution was to:

- Adopt emerging computer technology that is energy efficient.
- Allow the use of laptops and tablets within the environment.
- Investigate the use of desktop virtualization to offset the need for desktops to handle the CPU load.
- Use timer switches to power down non-essential areas after hours and educate users about electricity saving habits

**Implementation process**

The CPU and motherboards of today's computers are far more energy efficient than those of 2009. For example the following simplified chart shows the drop in power consumption since 2009:

| YEAR | CPU Type/Manufacturer | Power Consumption (Watts) |
|---|---|---|
| 2009 | Intel Core 2 Duo E-Series | 65W |
| 2015 | Intel Core i7 Haswell | 35W |
| 2015 | Intel Atom (Dual Core) | 10W |

*Power reduction through energy-efficient technology*

During the 6 years since the onset of "load-shedding" in South Africa, the CUA at the Faculty of Medicine & Health Sciences went through 4 different models of PCs. With each update, the power consumption of the new model computers were measured using a simple off-the-shelf power meter:

| YEAR | Computer | Power Consumption including Screen |
|---|---|---|
| 2009 | HP Compaq DC7600 | 312W Operational/83W Idle |
| 2010 | Dell Optiplex 760 USFF | 116W Operational/18W Idle |

| | | |
|---|---|---|
| 2013 | Dell Optiplex 790 USFF | 51W Operational/15W Idle |
| 2015 | HP T620 Thin Client | 9W Operational/2W Idle |

There has been a sustainable 97% reduction in power consumption since 2009. In 2009 a 60KVa UPS (Uninterruptable Power Supply) was installed in the CUA to power the area during power cuts and "load-shedding". The total demand of the area gave the CUA between 26 and 34 minutes of autonomy (the maximum time that the batteries in a UPS can sustain the load of the equipment that it is powering) in 2009. That same 60KVa UPS has between 72 and 94 minutes of autonomy (as measured in December 2014).

*Adoption of laptop and tablet technology*

In 2013 a strategic decision was made by faculty leadership to investigate the use of BYOD (Bring Your Own Device) technology within the Faculty, as a means of addressing the chronic shortage of computer facilities, especially during exams.

Although the primary concern for BYOD was the establishment of a secure exam environment, where student devices would not compromise the university network security, some attention was given to the potential power savings of BYOD as a technology. It was estimated that during BYOD exams, if half the students would be using laptops/tablets not plugged into power, then an estimated saving of 4.5Kw per hour would be possible as most laptops use between 16-20W, and battery charges can last between 2 and 4 hours. (There was no power monitoring meters in the exam room to quantify the power consumption, so these are conservative estimates)

*Desktop Virtualization*

With ordinary desktop computers, the CPU and RAM of the desktop computer itself are responsible for the processing power. All modern-day computer CPUs are capable of "ramping up" their processing speed, on demand, by increasing the voltage to the CPU. (So a desktop computer uses more power when processing and less power than idling.)

Desktop virtualization transfers the demand for RAM and CPU power to a large array of servers known as a virtual host. With desktop virtualization, desktop computers, laptops or tablets only have a small client installed on them that allows them to connect to the virtual host and to run a virtual desktop on that host. The demands on the device are minimal, as all the processing demands are now handled by the virtual host. This effectively transfers the need for powerful desktops in Computer User Areas at the faculty to "thin clients". (Low-cost, centrally-managed computers devoid of CD-ROM players, diskette drives, and expansion slots.)

Generally thin clients are not as vulnerable to malware attacks, have a longer life cycle, use considerably less power and are less expensive to purchase. The table below shows a conservative estimate of the drop in power consumption of the CUA from autonomous desktops to thin clients using desktop virtualization.

Of course the power consumption of the thin clients has to be offset against the increased cost of and power consumption of the virtual hosts, but a recent article by EnergyStar-, a US Environmental Protection Agency tasked with finding ways of protecting the climate and saving money through energy efficiency - indicated that virtualization resulted in a significant saving in ROI and energy because virtualization concentrated the demand for processing within a single virtual host instead of spreading it throughout numerous servers and desktops that were underutilized.

| YEAR | Computers | Power Consumption (kWh) |
|---|---|---|
| March 2014 (without desktop virtualization) | 150 Dell Optiplex 790 USFF | 7.7 |
| June 2015 (with desktop virtualization) | 150 HP T620 Thin Clients | 0.14 |
| | | 98.2% reduction |

*Timers*

A further saving in the electricity consumption of the CUA was achieved by installing timer switches in areas within the CUA that are not used after hours. The percentage of usage of the 3 “open areas/electronic classrooms” drops from an average of 70% (08h00-16h00 weekdays) to a mere 8% after hours. Timer switches were put in 2 of the 3 areas to switch off the lights and to switch off the air-conditioning after hours and over weekends. Secondly the security card access system was also adjusted to prevent students from entering the two “closed” areas after hours, forcing them to use the single open area that is open 24/7. The computers in the two closed areas are scheduled using remote management software to shut down after 16h00 in work days and are “woken up” at 07h00 the following day.

Although there is no power metering on the air-conditioning and lights at this time, 0.9KwH are potentially saved by switching off 100 of the 150 computers.

*Education*

Students at the Faculty, although they are regarded as “clients” they are also “consumers” and educating them to be careful with their consumption of electricity within the CUA proved to be a challenge. Informing the students ahead of time about areas of the CUA that were being shutdown to conserve electricity proved somewhat successful, but this information was reinforced by switching off the lights automatically 15 minutes before the air-conditioning was shut down and the card-controlled security doors were deactivated for entering. These visual clues helped students to adjust their habits. It was found that after a month of instituting these power conservation measures, students were already moving out of the areas that were scheduled to shut down before the lights were turned off. Changing habit and expectations proved to be the hardest part of the exercise and constant reinforcement and “policing” is required.

**Next Steps**

The reduction of power consumption within the CUA at the Faculty of Medicine and Health Sciences has been largely achieved with currently available technology, and the CUA is now investigating the use of photo-voltaic panels and wind turbines to supplement and even remove the need completely for ESKOM power for the medium to long-term future.

**Demographic information**

The Faculty of Medicine and Health Sciences, Stellenbosch University, is situated in Cape Town, South Africa. The campus consisted of 23 buildings with a combined floor area of 58743m2. There are 10 departments that provide teaching to health science students, perform research and provide clinical service.

**Links**

ESCOM - What is load shedding? http://loadshedding.eskom.co.za/loadshedding/description
Dell Infographic: Avoid disaster with BYOD survival cheat sheet
https://powermore.dell.com/technology/avoid-disaster-with-this-byod-survival-cheat-sheet/
Desktop Virtualization in K-12 Schools:
http://www.cisco.com/web/strategy/docs/education/CenterForDigitalEducation-VMware-Desktop-Virtualization-in-K-12-Schools-WP1.pdf
EnergyStar – Data Center Energy Efficiency Strategies – Server Virtualization:
https://www.energystar.gov/index.cfm?c=power_mgt.datacenter_efficiency_virtualization

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