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# Reducing Energy Wastage From Desktop Computers

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# Reducing energy wastage from **desktop computers**

Electronic office equipment is expected to have the highest growth rate of all the end-uses of energy in the North American commercial sector. Researchers are obtaining data on actual computer use profiles to make more realistic estimates of the energy and cost savings that can be achieved by tailoring electricity consumption to actual computer use

BY GUY R. NEWSHAM, PH.D., AND DALE K. TILLER, D.PHIL.

Desktop computers and associated peripherals often remain switched on when they are not in use. Electrical energy is therefore wasted in two ways: directly by unnecessarily powering computers and peripherals; and indirectly through the increased load on the building cooling system. The Institute for Research in Construction of the National Research Council of Canada (IRC/NRC) is studying the magnitude of this waste, and identifying cost-effective ways to ensure that equipment is switched off when not in use.

Electronic office equipment is expected to have the highest growth rate of all the end-uses of energy in the North American commercial sector. By 1995 there will be up to 65 million personal computers in the United States alone. Estimates for office equipment electricity use for the same year range from 25 TWh to 130 TWh (1 TWh = 1 billion kWh)[1]. Although newer equipment consumes less power, the total energy consumption by electronic office equipment is expected to rise throughout the nineties.

There are no reliable data on current electricity loads or operating profiles for statistically sampled sets of computers and peripherals. The relatively high estimated power density typical of current use (10 to 20 W/m$^2$), along with the possibility of explosive future demand, suggests a detailed study of loads and operating profiles is appropriate. If necessary, cost-effective means to manage the load should be identified.

### Rated vs. plug loads

The measured power consumption of electronic office equipment is often considerably lower than its nameplate rating. Therefore, any assessment of energy consumption (and cooling load) based on nameplate ratings may be an overestimate.

We measured the idling power consumption of almost 500 personal computers, monitors, and printers. Figure 1 (on page 16) shows that for computers only (monitors and all other peripherals were disconnected except in the case of the Mac SE, which has a built-in monitor), the ratio of rated power consumption to measured power consumption was about 3-4 to 1. The error bars represent the standard deviation of the measured power consumption. AT-286's and AT-386's, made by a number of different manufacturers, showed considerable variation in measured power consumption. Even computers from the same manufacturer, for example the Mac SE, showed some variation.

The ratio of rated power consumption to measured power consumption was around 2 to 1 for monitors, and as high as 20 to 1 for printers.

Idling power consumption is a good estimate of average power consumption for computers and monitors. The power used by computers did not increase significantly when accessing a disk or running a program nor did the power used by monitors decrease significantly when "screen saver" programs were used. However, printer power consumption rises significantly during operation. Consequently, the average power consumption of a printer will vary with the frequency of use.

Knowing the average power consumption we can predict the energy savings that would result from switching off computers and peripherals when they are not in use. (See sidebar.)

### Real use profiles

We are currently obtaining data on actual computer use profiles, using a sample of about 150 computers.

## Potential savings under two different usage schedules

Measured average power consumption of computers and peripherals can be used to predict energy savings for assumed use schedules. In an extreme case, a 150 W workstation (comprising computer, monitor and printer) used for only 4.5 hours per working day but always left on (including nights and weekends), uses about 1310 kWh of electrical energy per year; if it were switched off when not used, consumption could be as low as 172 kWh per year. The heat generated while the computer is running but not used adds to the building's cooling load, further increasing electrical energy consumption. Table 1 shows estimated costs for two different operating schedules, and three charge rates.

***Table 1 — Estimated electricity costs (dollars per year) for a 150 W personal computer system operating under two different schedules***

| Operating Schedule* | Computer Use (kWh/yr) | HVAC Use** (kWh/yr) | Total Electricity Cost | | |
|---|---|---|---|---|---|
| | | | @ 3 cents/kWh | @ 6 cents/kWh | @ 12 cents/kWh |
| 1 | 1310 | 528 | $55 | $110 | $221 |
| 2 | 172 | 304 | $14 | $29 | $57 |

*1 = Power to computer 24 hrs/day, 7 days/wk
2 = Power to computer 4.5 hrs/day, 5 days/wk
**HVAC use calculated for an interior office in Toronto, using an hourly building thermal simulation model

Changing the schedule from continuous operation to a 4.5 hour operating period per day, five days per week could realize savings of up to $164 per year, per workstation, at the highest example electricity rate. Even greater savings would accrue in warmer and/or more humid climates, where HVAC loads are much larger than in Canada. Given the estimates of rapid growth in the use of electronic office equipment, the potential savings are enormous.

More efficient computer use achieved by turning equipment off when it is not being used could also lead to reductions in peak power demand, and lower demand charges for consumers.

## ENERGY MANAGEMENT

These profiles will allow us to make realistic estimates of the energy and cost savings that can be achieved by tailoring electricity consumption to actual computer use. We have developed software, installed on a computer's hard disk, to monitor keyboard activity.

Thus, we can identify periods when the computer was switched on but there was no keyboard activity. For most users, this implies that the computer was not being used, and so, if the computer and peripherals were switched off, energy savings would accrue. In addition, we will be able to correlate computer use to time of day, enabling us to analyze the effects of computer use on peak demand.

### *Tailoring power consumption to actual use*

The final phase of the project will examine ways of ensuring that computers and peripherals are switched off when not in use. We are considering two possibilities: placing stickers on or near workstations reminding users to switch equipment off (successful in encouraging people to switch off lights when leaving the office)[2]; and a device that selectively powers down equipment after a designated period of inactivity. We plan to try both on user samples and assess their effectiveness using the monitoring software described above. If significant savings can be realized using these techniques, utilities might wish to consider offering financial incentives to encourage the use of energy-efficient equipment and practices, similar to the incentives offered for energy-efficient lighting.

Many users leave their computers on at all times because they fear hardware failures associated with power cycling. Manufacturers of computer chips, monitors and hard drives report that new equipment should experience no reduction in life expectancy due to power cycling, provided correct shut-down procedures are followed.

We believe the issues raised in this article are extremely important in a world where the environmental and political costs of power generation are coming to the fore. We wish to acknowledge the funding provided for this project by the Canadian Electrical Association and Energy, Mines and Resources Canada.

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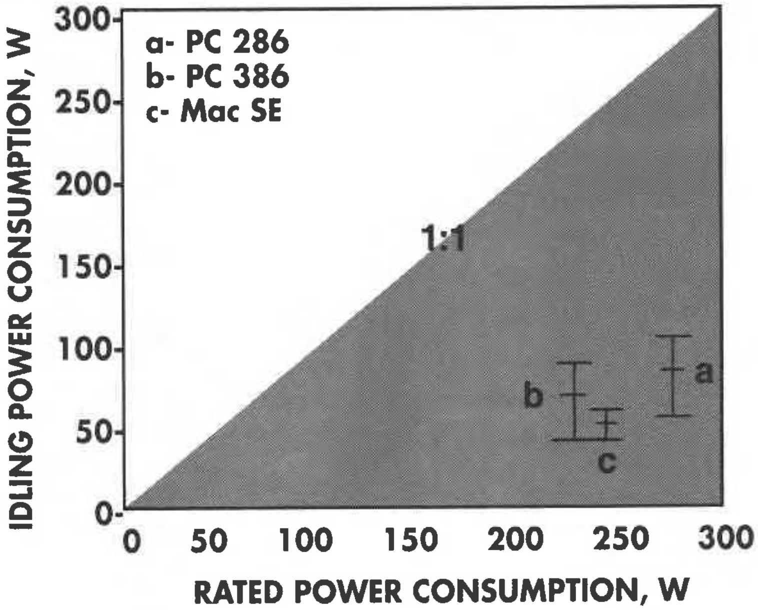
***Figure 1 —***
***Idling power consumption vs. rated power consumption for computers***




*Many examples of each computer type were measured, the bars represent the standard deviation in these measurements.*

***Footnotes*** *:[1] L. Norford et al. Electronic office equipment: the impact of market trends and technology on end-use demand for electricity. Electricity, Lund University Press, Sweden, pp. 427 - 460 (1989).*
*2 M.S. Rea et al. The effectiveness of light switch reminders in reducing light usage. Lighting Research and Technology 19, pp. 81-85 (1987).*

**For more information, circle no. 81**