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**Publisher's version / Version de l'éditeur:**

*Canadian Facility Management & Design, pp. 12-13, 2010-04-01*

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## IRC-VISI-462

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April 2010

A version of this document is published in / Une version de ce document se trouve dans:
*Canadian Facility Management & Design,* pp. 12-13

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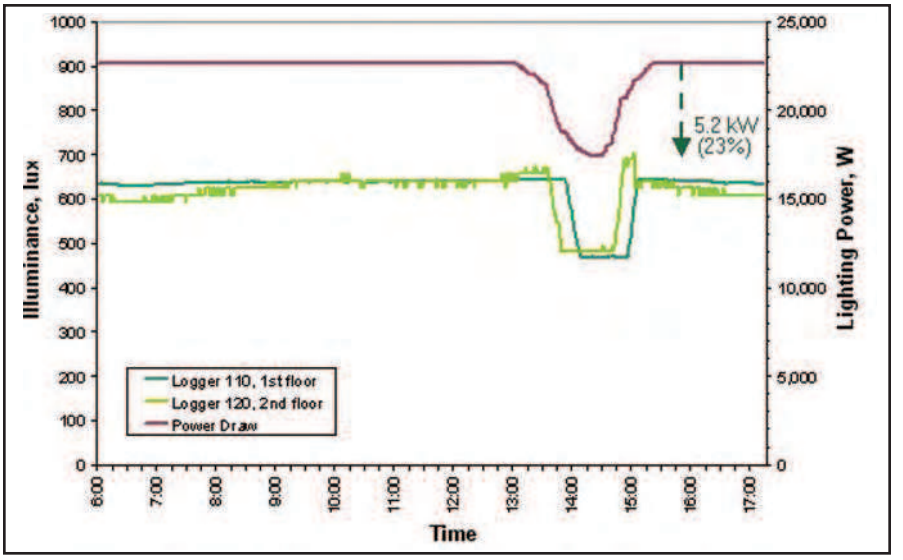
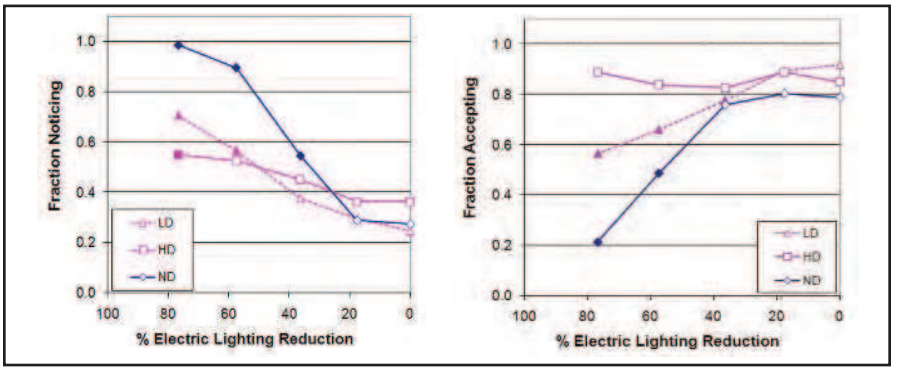
# DIMMING FOR PEAK DEMAND REDUCTION

National Research Council studies indicate that temporarily dimming lighting could be a viable means of achieving peak demand reduction




*This graph relates to the research studies conducted in a federal office building. It shows total power drawn by the lighting system in the building study zones, and two sample interior illuminance measurements, for one load shed trial enacted in the afternoon.*




*The two graphs above represent the mean fraction of occasions that a change in lighting was noticed (left) or acceptable (right), by size of reduction from baseline, and amount of prevailing daylight. ND = non-daylit. LD = below median prevailing daylight. HD = above median prevailing daylight. Open sysmbols indicate fractions that did not differ significantly from the no-change case (0 pe cent reduction) for that daylight condition; closed symbols indicate a significant difference.*

Massive power failures are particularly likely to occur at peak demand times, when the margin between the amount of power the grid can supply and the quantity of electricity being consumed is particularly slim. And while it might seem likely that energy demands would be shrinking in these sustainably minded times, that's not the case, says Guy Newsham, Ph.D., senior research officer with the National Research Council's Institute for Research in Construction in Ottawa. Although there was a blip of a downturn in building energy use in North America in 2009 – attributable in part to an economic crisis and in part to cooler-than-usual summer temperatures – demand was increasing before that and is forecast to continue increasing. And in Ontario, peak demand is growing faster than overall energy use. (Peak demand times in Ontario are hot summer afternoons when air conditioning is on at full blast and electric lighting in most offices is blazing. In parts of Canada with more severe winters, however, peak demand periods tend to occur when it's cold outside and the heat has been cranked up within.)

Much of Dr. Newsham's research has to do with load shifting or load shedding in the corporate and institutional sectors, which is to say, shifting the times when a facility's energy demands are highest away from the general peak demand spike (through strategies such as using a building's thermal mass for heating and cooling), or reducing the amount of energy a facility is consuming at peak demand periods. Late last year at the Construct Canada conference in Toronto, Dr. Newsham shared some of his findings in the latter area in a compelling presentation titled "Making Buildings Responsive to Peak Energy Demand: Saving the grid without affecting productivity." In essence the results indicate that people in offices or educational environments not only tolerate but in most cases do not even notice significant light dimming or increases in temperature of up to 1.5° C, provided that these changes occur smoothly and gradually.

In one of the National Research Council (NRC) studies discussed, participants spent a day completing questionnaires and standard office tasks in a full-scale office laboratory environment illuminated by direct-indirect

luminaires using 3500K T8 fluorescent lamps. A control group experienced constant lighting and ventilation conditions. Through the use of dimming controls, a second group experienced a reduction in workstation illuminance of 2 per cent per minute over a 30-minute period. This second group also experienced an ambient air temperature increase of 1.5° C over 2.5 hours. Participants were not told that these changes would occur. While some in the second group did perceive a change, they did not rate their 'environmental satisfaction' lower during the period of higher temperatures and diminished lighting levels, and it did not seem to affect their performance of tasks such as typing and anagram solving.

A third group had personal dimming control over lighting at their workstations, along with the ability to adjust ventilation rate via an overhead nozzle. Results showed that 20 per cent of the participants had chosen to increase light levels by the time that desktop illuminance had declined approximately 35 per cent from their initial preferred level, and 50 per cent of the participants took action to raise their lighting levels when desktop illuminance had declined by approximately 50 per cent.

In a second laboratory study, participants in an office laboratory received a baseline desktop electric lighting level of 400 lux. The lighting was dimmed smoothly over a 10-second period. During the dim, and for 30 seconds afterwards, participants performed a computer-based proofreading task. They were asked whether they noticed a change in lighting, and whether the lighting conditions were acceptable. The exercise was repeated over multiple trials, with dimming intensity varying from zero to 80 per cent, in settings with or without daylight. And the results? "The level of dimming not noticed by occupants was 20 per cent with no daylight, 40 per cent with relatively low prevailing daylight, and 60 per cent with high prevailing daylight," the study concluded. Furthermore, participants rated the lighting levels "acceptable" when a 40 per cent dimming occurred when little or no daylight was present, and when an 80 per cent dimming occurred with high prevailing daylight.

In a subsequent field study in a federal office building, lights were dimmed by up to 35 per cent over periods of 15 to 30 minutes, achieving a power reduction of just over 5 kW (23 per cent lower than pre-test power demand levels) – and there were no lighting-related complaints.

"From these studies," Dr. Newsham concluded, "one can begin to develop guidelines for demand-responsive dimming that could be included in recommended practice documents or standards for office lighting, and referenced in utility demand response programs." Even in spaces with no daylight, these studies suggest, a rapid-response dimming of 20 per cent could occur over as short a time as 10 seconds without the large majority of the occupants noticing the change. A slow response, conducted over 30 minutes or more, could reduce lighting by as much as 30 per cent in spaces with no daylight, once again without detection by the majority of the occupants. In spaces with high prevailing daylight, a dimming of up to 60 per cent could be achieved without being noticed by most occupants.

"Dimming lighting is something that could be done when the demand [for electricity] is really close to exceeding the supply," Dr. Newsham observed. He added, however, that the absence of dimming technology in most office buildings is an obstacle: although approximately two-thirds of LEED®-certified projects incorporate lighting control systems, these systems are installed in only about seven per cent of all U.S. office space. "I wouldn't expect anybody to install dimming systems just for the purposes of demand response," Dr. Newsham said. "You'd install a dimming system to save energy through daylight harvesting and occupancy sensing. But once you have a system in place, being able to participate in demand response programs could be the icing on the cake."

He also cautioned that bringing lighting down and cutting back on air conditioning on hot summer afternoons are "temporary measures to be used in extreme circumstances" and should not become the new normal. "Under normal circumstances I think lighting systems should provide conditions that people prefer, not just what they'll tolerate," he said. "There's lots of evidence to suggest that the preferred average levels are what we would consider typical normal recommended practice." Extensive information about the research projects discussed here and other NRC Institute for Research in Construction studies is posted at http://www.nrc-cnrc.gc.ca/eng/projects/irc/demand-responsive.html. | **CFM&D**

GRAPHS: DR. GUY NEWSHAM