LBNL-44281

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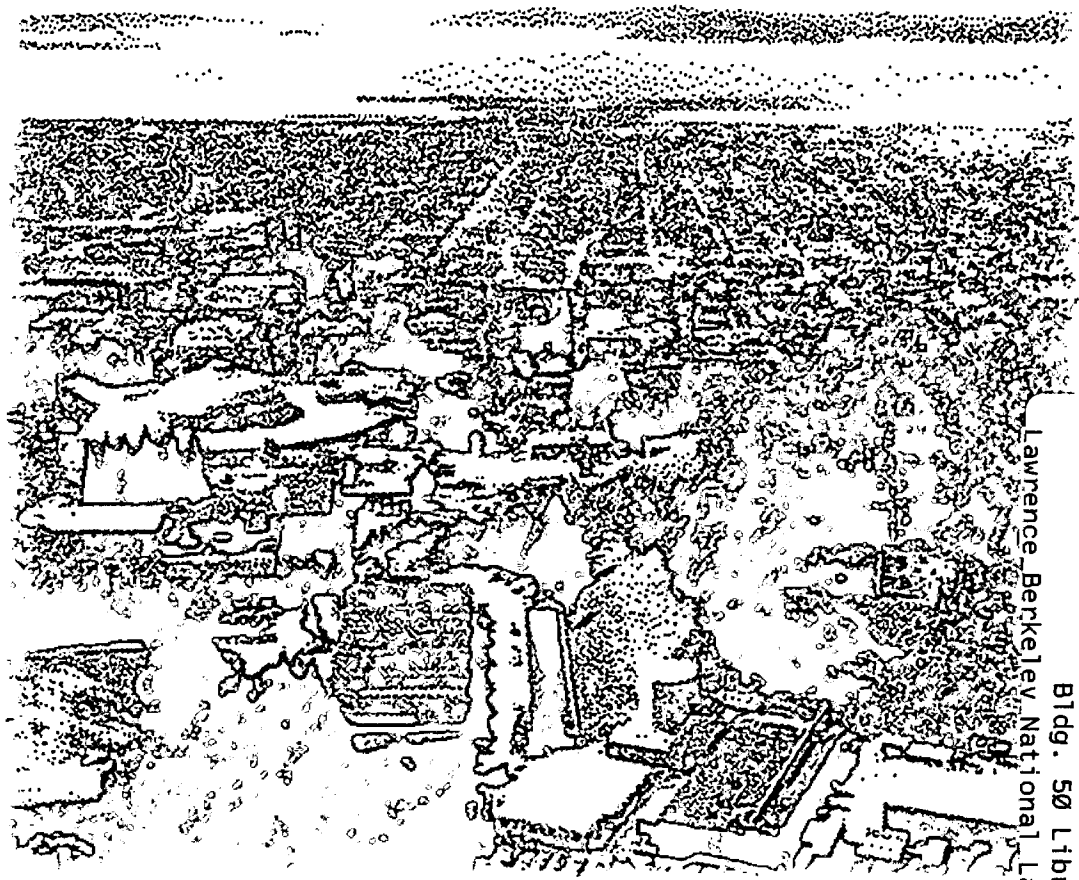
The Usefulness of Bi-Level Switching

Original Technical Note: November, 1998
Revised August, 1999

Environmental Energy Technologies Division

November 1998



DISCLAIMER

LBNL-44281
LG-215

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This work was supported by the General Services Administration, Pacific Rim Region; the Pacific, Gas & Electric Co.; and the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, State and Community Programs and Office of Federal Energy Management Programs of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

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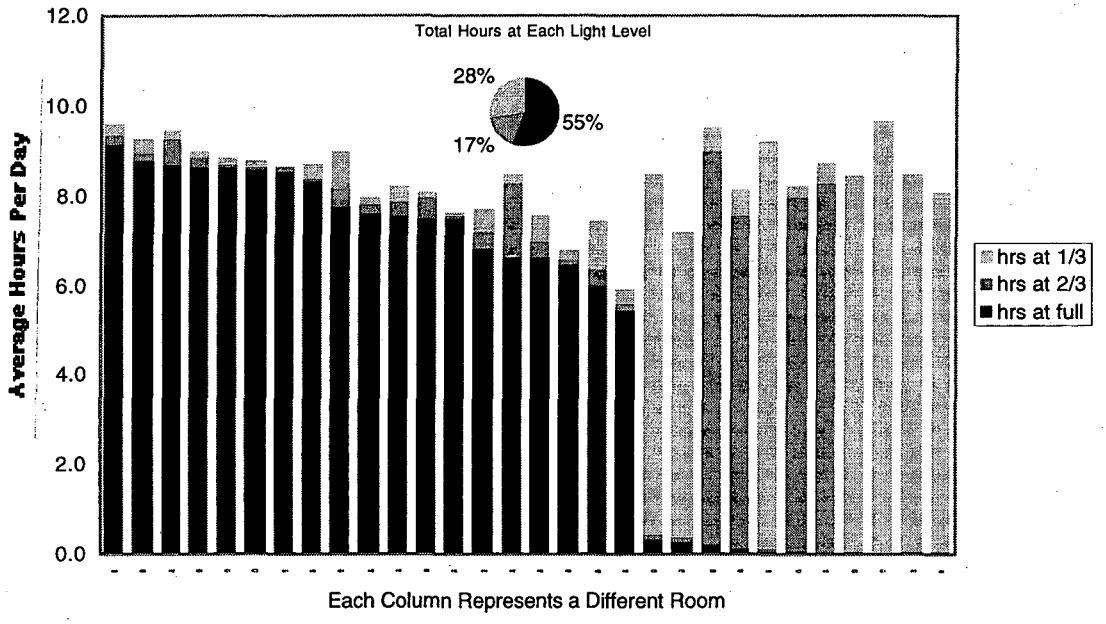
California's Title 24 Energy Efficiency Building Standard requires multiple lighting level control in all individual offices. Usually, this requirement is fulfilled using bi-level switching. With bi-level switching, each office occupant is provided with two wall switches near the doorway to control their lights. In a typical installation, one switch would control 1/3 of the fluorescent lamps in the ceiling lighting system, while the other switch would control the remaining 2/3 of the lamps. This allows four possible light levels: OFF, 1/3, 2/3 and FULL lighting.

Because it has been required by building code since 1983, bi-level switching is common in California office buildings. However, there is no published evidence showing that occupants sometimes use just one switch rather than just switching on both switches when entering the room. Consequently, some have questioned whether bi-level switching is a necessary or desirable requirement for typical office buildings. In fact, the draft national standard, ASHRAE Standard 90.1-1989R, apparently does not require bi-level switching at all.



In this research note, we analyze the wall switch usage patterns for 30 private offices at the San Francisco Federal Building at 450 Golden Gate Avenue to determine whether these occupants use their bi-level wall switches effectively. At this installation, the ceiling lighting power for each office is collected at 15-min intervals. Seven months of data (June 1998 - December 1998) were analyzed for this initial data analysis. All these offices are perimeter offices so daylight is available. However, apart from two manual wall switches, there are no other lighting controls in these offices. The occupants were not instructed in the use of the switches.

We used the measured energy data for each of the 30 offices to compute the average number of hours a day that the occupants set their lights to 1/3, 2/3 and FULL light level. Only weekdays in which the offices were substantially occupied are included in the sample. The data for the seven month period between May and December, 1998 is presented in the figure below. Note that while most occupants use full lighting, four (13%) use mostly 2/3 lighting and seven (23%) use only 1/3. Thus the bi-level switches are used effectively (i.e., the occupant call for less-than-full lighting) by a significant number of occupants of this sample. Even those occupants who primarily use full lighting sometimes use only one switch for the entire day.

The inset pie chart shows the percentage of total lighting hours in this sample that the lighting was at the different light levels. 45% of the lighting hours were at less than full lighting with 28% using only 1/3 lighting.

Finally, we estimate the energy savings attributable to the use of bi-level switching for this office sample. The mean number of lighting hours per day is 9.1 hr/day. But there are only 6.9 hr/day of "full-equivalent" lighting because a significant fraction of the total lighting hours is at reduced level. This represents energy savings of 24%.

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Acknowledgment

This work was supported by the General Services Administration, Pacific Rim Region; the Pacific, Gas & Electric Co.; and the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, State and Community Programs and Office of Federal Energy Management Programs of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

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Prepared for the U.S. Department of Energy under Contract No. DE-AC03-76SF00098