Smart strategy can save open-plan offices up to 25 percent of energy on lighting

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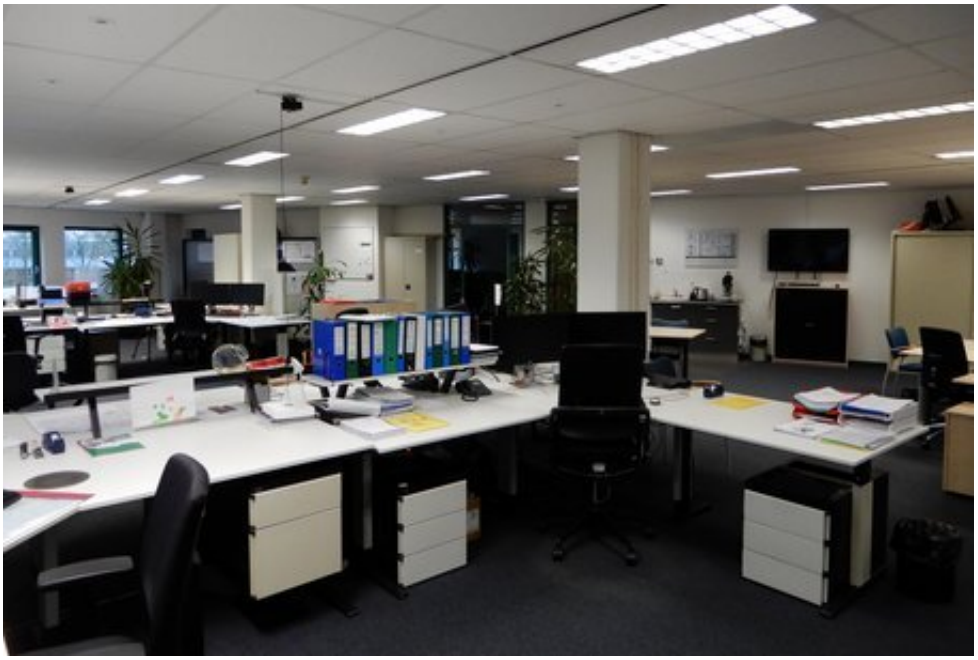


An example of a Dutch open office without partitions. Credit: Christel de Bakker

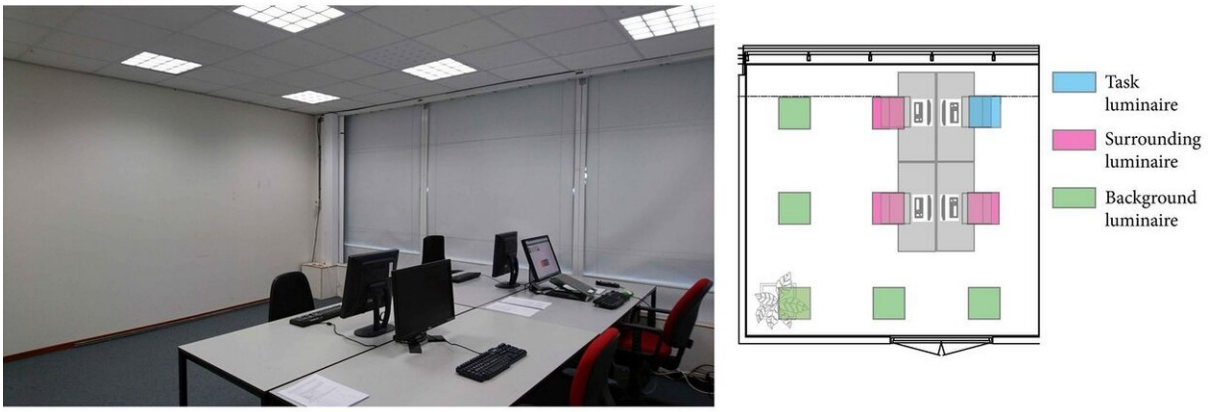
Increasingly, employees share a large open office with flexible workplaces and working hours, leaving many desks vacant for large parts of the day. But the lighting is still on the whole day, in the whole office. Smart lighting with motion detectors can significantly reduce energy consumption in offices, but when light sources are frequently switched on and off, this becomes unpleasant and distracting. Researcher Christel de Bakker has developed a method to set the lighting in such a way that

the lighting energy consumption is reduced by more than 25%, without compromising user comfort. She will be awarded her Ph.D. on this subject on June 4th at Eindhoven University of Technology.

De Bakker's research comes at an opportune time. By 2023, all Dutch office buildings must have a minimum energy label C. Lighting takes up to 15% of the entire energy consumption of an office building, while the light is often on in places where no one is working at that moment. Presence sensors can ensure that the light is only switched on over occupied desks. But the large contrast of light between an occupied and an unoccupied desk turns out to be unpleasant. In addition, employees are distracted by the ever-changing light intensity.

Dimming on three levels

In order to find out the best lighting strategy for employee comfort, De Bakker set up two darkened research areas of different sizes as an office. She then asked the subjects, 95 in total, to set the lighting in a way that felt comfortable. Using these results, she then tested the lighting set-up that had been most frequently chosen in a real open office, and asked the employees there, 20 in total, to evaluate the lighting conditions. De Bakker: "The test subjects were not able to switch off the light completely in these experiments because earlier research showed that this caused unpleasantly large light contrasts in the area. So employees could only dim the light."



The research set-up for a medium-sized office. The subject sits at the desk with the lamp indicated in blue. For the best lighting strategy, the user's desk is the most brightly lit. The three surrounding desks (pink) are slightly dimmed, while the lamps in the area (green) are dimmed the most. Credit: Christel de Bakker.

De Bakker discovered that an office with three light levels is the best strategy. If an office worker is working alone in a medium-sized open-plan office, the desk at which the user is working should be fully lit. The lamps above the three surrounding desks may be slightly dimmed (35-65 cd/m2), and the lighting in the rest of the room may be dimmed even more (20-50 cd/m2). De Bakker calculated that this would enable you to save more than 25 percent of the energy consumption for lighting in a medium-sized office. The size of the space appeared to be important for perception. "If you work in a large room, you will feel like you want to know what is going on in the background, so the backlight has to be set more brightly," says de Bakker.

Luminance meter

De Bakker does see significant differences in individual preferences. A combination of locally set preferences per desk, supplemented by a standard lighting plan for the entire room, is therefore the best solution: "People still want to adjust the light at the beginning of the working day, but they quickly forget about it during the day."

De Bakker hopes that her plan will be put into practice. But this requires a luminance sensor. "In my research I have focused on the luminance (cd/m2) instead of the more common illuminance (lux). Luminance is the brightness experienced by the observer, and also includes the reflection of light on objects, for example. Therefore it is a better measurement method to determine the perception and comfort of the employee," says De Bakker. Unfortunately, today's smart lamps are currently only equipped with a lux meter. Her fellow Ph.D. student Thijs Kruisselbrink is therefore developing a luminance meter. He's now halfway through his Ph.D. research.

De Bakker has published some of her results in the *Building and Environment* journal.

More information: Christel de Bakker et al. The feasibility of highly granular lighting control in open-plan offices: Exploring the comfort and energy saving potential, *Building and Environment* (2018). DOI: 10.1016/j.buildenv.2018.06.043

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