ZERO ENERGY COMMERCIAL BUILDINGS CONSORTIUM

Daylighting Subgroup

Lighting Working Group

Zero Energy Commercial Buildings Consortium (CBC)
Daylighting sub-group Call Notes
July 7, 4:30 – 5:30 pm EDT

Attendees:

- *Jim Lewis, NEMA, Working Group co-chair*
- *Brad Hollomon, ZE CBC*
- *Jeff Harris, ASE*
- *Rob Guglielmetti, NREL*
- *Teren Abear, S. Cal. Edison*
- *Govi Rao, Noveda*
- *Helen Sanders, SAGE*
- *Chris Chatto, ZGF Architects*
- *Chris Meek, Integrated Design Lab / UW Seattle*
- *Kyle Konis, UC Berkeley Ph.D student / LBNL*
- *Pekka Hakkarainen, Lutron*
- *Mark Perepelitza, ZGF Architects*
- *Abi Kallushi, ASE*

The following outline/notes reflect the phone conference discussion of the sub-group on July 7. These topics will be discussed further in a second conference call, and then forwarded on to the Working Group to be incorporated into their report. As we discussed, since our topic overlaps significantly with the Building Envelope Working Group, these notes will be shared with them as well. Please review and provide additional comments by email or by phone in our next call.

Thanks for your input!
Mark Perepelitza
ZGF Architects

I. General daylighting objectives (today and future)

a. Support net zero energy goals by significantly reducing use of electric lighting through daylight distribution and management, as well as integration with lighting control systems.
   Daylighting should be achieved without compromising other aspects of building envelope performance including managing solar heat gain and managing heat transfer through insulative properties. (Konis)

b. Improve occupant comfort, productivity, and well-being through access to natural light.

c. Support architectural design and aesthetic intentions through use of natural light to enliven building form, interior spaces, and materials.

d. Measure and report actual building energy performance (kBTU/sf/yr). Simulated and installed equipment data is not enough. One participant recommends that poor performing buildings be penalized

II. Current state of daylighting buildings—standard practice / best practices

a. Design—massing, orientation, window-to-wall ratio (WWR), window placement

   WWR has become a controversial topic lately—some believe that WWR must be reduced significantly to reduce energy use, other advocate greater flexibility depending on climate, building type, and facade configuration to encourage daylighting. The trend with codes and standards is to reduce WWR. (Hakkarainen) One problem with this trend is that once a building's WWR has been established, it is unlikely to be modified in future renovations even though technologies may be developed that could make a somewhat larger WWR more energy efficient. For horizontal buildings—skylights also become an important component for providing daylighting. (Sanders)

   In many buildings perimeter spaces deprive interior spaces of daylighting—for example perimeter offices block light to interior office space, perimeter hospital rooms block light from interior staff work spaces. There are some buildings that are an exception and are well-planned for daylighting, but they are a small exception. (Meek, Hollomon)

b. Low tech—interior daylight management elements (manual venetian blinds and roller shades)

c. High tech—automated interior and exterior daylight redirection and management systems

d. Mid tech/hybrid—fixed and manual daylight redirection and management systems, split vision/daylight configurations.

e. Lighting control systems are typically not well-integrated. Although this topic is being explored by another sub-group, it is a big area of potential and obviously intersects with the topic of daylighting. Energy savings from daylighting is not possible without well-integrated controls. Proper use by building managers and building users is a challenging issue. (Guglielmetti, Konis)

f. Products in early stages of commercialization—electrochromic glazing and other products have recently become commercially available, but have not yet been widely adopted. Prices are currently high but are expected to fall.

III. Vision: daylighting buildings in 2030-2050

a. How much are buildings likely to evolve—including uses, types, and scale? Will this have implications on daylighting?

   Buildings will likely be very similar to today's buildings in their general configuration, but the uses and tasks within them may be significantly different. For example, recent and current use of computers and monitors drives many decisions regarding the building envelope, window coverings, and electric lighting systems. Future computers, monitors, and/or equivalent devices for work tasks are likely to be significantly different. (Konis)

Most of the good design principles that will make a difference in the next 20-40 years are already known. In new buildings, minimum codes need to acknowledge these good principles and require better design. Energy performance codes also need to be enforced, which will require that states dedicate money in their budgets.

b. Design—implications of massing, orientation, and window placement on daylighting (Traditional / non-traditional approaches)
Scale and floor-plate depth play a significant role. Narrower floor plates as seen in European buildings can increase the amount of floor area that can be effectively daylit. Building scale also impacts daylight availability—buildings that have three or few stories can be daylit from skylights as well as windows. To allow deeper daylight penetration, enclosed offices at the perimeter are likely to become less common.

c. New buildings—
How will daylighting be incorporated and managed for the major building uses/types? (office, residential, retail, civic, healthcare, education, manufacturing, research)
Nearly all types require daylighting and have significant potential. Hopefully in 20-40 years energy and daylighting will be strong drivers in building planning and design.

What role will daylight play in building energy use? Where is the greatest potential to support the goal of net zero energy use?
What role will daylight play for building users comfort, productivity, and well-being?
What kind of interaction will there be between building users and daylight?
What are the most significant hurdles?

d. Existing buildings—
What approaches are most likely to be taken to retrofit existing buildings to improve daylighting conditions?
Highly tinted glass (which prevents light from penetrating) will be replaced with high transmission low E glazing and dynamically controlled shading or glazing systems will be used to manage heat gain and glare. (Sanders)
Replacing glazing and window systems is quite expensive so it can be challenging for improved performance to show a reasonable cost benefit. The impact is also limited by the existing skin of the building—if the windows are small and low (20% WWR) good daylighting isn't possible. (Guglielmetti)
Retrofitting or adding skylights with appropriately controlled systems will also provide significantly more daylight to horizontal buildings. (Sanders)
To achieve net zero (or near net zero) with existing buildings, swapping the exterior glass, while expensive, it's not as expensive as other technologies. If our goal is to get the building to/near net zero, looking at the perimeter has advantage that were also looking at thermal effect – more energy savings and payback.
You can replace the glass within the existing framing system. There are varying degrees at which we can affect the building skin. One option is to change the entire framing system, the other is you keep the framing system and change the infill. For existing buildings the apertures are already fixed.

What role will daylight play in building energy use? Where is the greatest potential to support the goal of net zero energy use?

What role will daylight play for building users comfort, productivity, and well-being? What kind of interaction will there be between building users and daylight?

What are the most significant hurdles?
Buildings from the 60's and 70's typically were not planned for daylighting and have a very thick floor plate. New strategies and technologies can improve perimeter conditions. Moving natural light deeper into the interior and core areas is possible, but difficult and expensive and thus less likely to be realized. (Chatto)

New York City has demonstrated that a City government can play a role in building improvement, when they passed a local law that requires all buildings larger than 50,000 sq.ft. to be upgraded and brought up to current code by the year 2025. These sorts of policy instruments are likely needed to make a real difference in the existing building stock, as we have seen relatively few buildings take advantage of currently available tax incentives. Incentives are nice, but there is rarely enough money in them to make a real difference. (Hakkarainen)

IV. Vision: available technology in 2030-2050

a. Low tech—interior daylight management elements (manual venetian blinds and roller shades)
   Low tech systems can be very effective, but require more careful space planning around patterns of light, sky conditions, and building uses. (Meek)

b. High tech/mid tech/hybrid—fixed and operable daylight redirection and management systems, split vision/daylight configurations
   i. Remote daylight redirection systems—heliodons
   ii. Exterior daylight redirection/management systems
      Automated exterior venetian blind are can be very effective at redirecting daylight, managing glare and managing solar heat gain. In temperate climates (like Seattle) they can keep solar heat loads low enough that it is possible to eliminate cooling systems. In this scenario, overall costs can be reduced. Because they are dynamic, they open for more daylighting on overcast days. They also inherently adjust as needed to optimize daylighting for each solar orientation. (Meek)
      Exterior venetian blinds have significant potential for sunny and warm climates. Testing at LBNL on exterior venetian blind systems has shown up to an 80% reduction in solar heat gain. (Konis)
      Maintenance and durability are concerns for exterior venetian blinds. They must automatically retract in high winds to avoid damage. One option is to use them within a double-skin assembly, although this is rather expensive. Exterior venetian blinds are fairly common in Europe and have been used over the past 40 years. (Perepelitza)
      Accurate energy simulations for dynamic systems are particularly challenging because they are dependent on good control algorithms. EnergyPlus has the

capability, but the algorithms need to be developed further. COMFEN is an interface for EnergyPlus developed by LBNL that allows comparative studies of facade configurations. (Perepelitza)

iii. Interior systems

iv. Dynamic glazing systems can be effective for optimizing changing daylight conditions and can be used in conjunction with separate daylight redirection elements. (Sanders.)

v. Light tube and similar daylight redirection configurations—require physical space to move light and thus can be expensive and impractical.

vi. Fiber optic daylight redirection systems

c. Integration with control system (will primarily be covered by separate subgroup)

d. Integration with lighting system (will primarily be covered by separate subgroup)

e. Measurement and verification—
We need to start measuring building energy performance (kWh/sf/yr or kBTU/sf/yr) and not just the installed power of the equipment. Poor performing buildings should be penalized. (Hakkarainen)

V. Process and tools—current practices and vision for future

a. Design and simulation tools
The right tools can provide a feedback loop for both design and operations. The cycle is indirect, not direct. (Konis)
Many tools are not easy enough to use and thus are limited to large building projects where the costs of energy simulations are not a huge part of the total budget. Tools need to become accessible to all buildings so that various design choices can be explored and trade-offs can be made in a systematic fashion, say between the building envelope design and the mechanical and electrical equipment. (Hakkarainen)

b. Daylighting metrics

c. Physical testing

d. Delivery (construction/installation)
Contractual obligations may need to change. Today, contractors are "rewarded" (as measured in terms of their income) by lowest initial cost, which leads them to try to break any high performance specification. This path does not lead to net zero energy performance, so we need to change the contractor's metric to something else, such as life cycle cost. Contractors will have to be responsible for the on-going operational efficiency of the building, not just the initial cost. (Hakkarainen)

e. Installation competencies

f. Who is responsible?

g. Post occupancy measurement, surveys, and dashboards

VI. Key barriers

a. Product/system technology

b. Policy
   i. building codes/standards
      1. energy
      2. safety
      3. electrical
   ii. test and measurement
   iii. maintenance (see below)
   iv. sustainability

c. Market acceptance
   i. cost / reliability / practicality
      Many building owners and design team members do not believe that lighting control systems are reliable yet. (Sanders, Hakkarainen)
      Dynamic products are more expensive, less available, and require commissioning and maintenance. Reliable performance can help convince owners and design team members. Government support is needed to incent building owners. (Konis)
   ii. occupant comfort/safety

VII. Key developments and recommendations required to overcome barriers

a. Technology
b. Policy
c. Market acceptance

VIII. How do we get there?

a. Research and development—academic, National Labs, industry
   NREL and LBNL are doing good research and developing tools such as the Window 6 and COMFEN. Further research is needed. Broadly accepted rules of thumb would also be a significant help for early decision-making. (Meek)

b. Education

c. Professional practice
   Thorough case studies could show performance benefits to help persuade building owners (Sanders)