Can daylighting go viral?
By Jason Brain, Ciralight Global Inc.

When the media reports on sustainable energy systems, much of the focus seems to revolve around photovoltaics, wind, and geothermal energy production. Rarely do they focus on a design process that has been around since before electricity: daylighting.

Perhaps this is due to daylighting’s lack of excitement, or perhaps this is due to daylighting’s passive approach to saving electricity instead of producing it. Regardless of the reason for its lack of media time, daylighting provides benefits, both tangible and intangible, that make it a worthwhile part of any building’s energy plans.

Effective daylighting design and implementation offsets peak-electricity consumption during the daytime, enhances interior environments, promotes productivity in the workplace and classrooms, and is far better for occupant health than any artificial lighting. Despite these numerous benefits, the news media spends little time promoting the benefits, applications, or installations of daylighting products. What is the stigma?

Many skeptics insist that skylights, one of the most prominent daylighting devices, will leak, create glare, and cause heat gain. They assert that these drawbacks are enough to outweigh the many benefits of daylighting. However, in the past decade alone, the industry has made significant leaps in the efficiency and effectiveness of daylighting technology, offering a variety of building products, including tubular daylighting devices, light shelves, and prismatic skylights.

According to the American Physical Society, “Americans spend 90 percent of their time indoors, working, living, shopping and entertaining in buildings that consume enormous amounts of energy.”¹ That means the average American spends a staggering 21.6 hours a day indoors. And the buildings we spend our time in account for 41 percent of primary energy consumption in the U.S.

While there are many ways to generate electricity, whether sustainable or not, all have limitations and drawbacks. Daylighting, on the other hand, is a strategy that reduces the amount of electricity needed and takes advantage of one of the most consistent forms of energy this world has ever known; sunlight. Aside from cloudy days, daylight is as routine on Earth as each sunrise and sunset, and it will not run out of steam (or gas) any time soon.
What will it take to bring daylighting to the ‘renewable energy’ forefront? Will daylighting need to go hybrid and generate electricity? Heat water? Perhaps there is a need for a ‘World Daylighting Day’ to highlight the need for sunshine in our lives or an industry-wide social media campaign to increase public daylighting awareness.

The sooner we generate more media appreciation for daylighting, the greater the success of energy-efficiency and green building. Our health, our world, and our future depend on a more sustainable solution.

Successful daylighting isn’t simply about the numbers
By Eric Truelove, PE, GGA, LEED AP BD+C, The Renschler Company

Successful daylighting boils down to one simple outcome: the building occupants leave the lights off when daylight is available. This may seem easy, but it is actually difficult to achieve since occupants always have the option of manually turning the lights on, even if that means overriding the daylighting controls. It reminds me of the challenge heating and cooling engineers face when they try to design a system that delivers adequate comfort. It’s easy to design a system that keeps a room between 70 and 75°F year-round but comfort is subjective, not simply a numbers game. Set the thermostat to provide any temperature over this range and I can almost guarantee people are looking to change the setting on the thermostat. That same problem challenges daylighting professionals.

Our eyes are extremely sensitive, much more so than our skin, and we react immediately if our eyes become uncomfortable due to glare, contrast, or the perception of being closed in. One interesting reaction to glare is counter-intuitive in that people will switch lights on and increase lighting levels so that the contrast indoors, between areas with direct sunlight and those without, goes away. Look at the following exterior picture taken of a building with large amounts of glazing on a bright sunny day:

![Fig. 1: Well daylit space with electric lights on. (Photo credit: E. Truelove)](image)

Note all of the lights are on even though this building has a glass curtain-wall. This is a classic lose-lose for energy efficiency. The large glass areas absorb enormous amounts of unwanted solar heat during the cooling season and lose large amounts of heat to the outdoors during the heating season. Furthermore, since the occupants keep the lights on, daylighting is not effective in reducing electric lighting demand.
If we used a light meter, I have little doubt the lighting levels in this building within 20-feet of the glass would read 35- to 100- foot-candles on a clear, sunny day which is more than adequate for office activities. So, why do occupants turn the lights on when so much daylight is available? Their eyes are not comfortable with the contrast so they use the lights to make the contrast go away. In most cases, they override any daylight controls and switch the lights on without even thinking about it.

Another example of daylighting that did not work completely is shown below:

![Fig. 2: Dark finishes in daylit spaces can negate an otherwise good design. (Photo credit: E. Truelove)](image)

In this case, the designers did almost everything right with one small exception: the carpet absorbs too much light which caused the occupants to override the lighting controls and switch on the lights near the curtain-wall glass even though it is a clear, sunny day outside. The glass areas are generous with an adequate overhang to prevent direct sunlight from entering the space, the ceiling is finished and highly reflective, and the light fixtures are mounted parallel to the exterior wall. All of these attributes are good daylighting strategies. But, the decision to put in a grey carpet detracted from the desired outcome even though it follows good design practice. The designer who specified the carpet probably wanted to have a color that would not show wear and dirt in high traffic areas. To that end the carpeting decision was a good one, but from a daylighting perspective the outcome was a disappointment since the lights are on.

The litmus test for successful daylighting is simple: walk into the day-lit space on a sunny day, look up at the ceiling to see whether the lights are on and see that they are off. A working design actually tricks occupants into thinking the lights are on. When people think the lights are on it is because their eyes are comfortable with the surroundings and they have no inclination to reach for the light switch.

A successful outcome is not easy as it involves decisions made by many professionals including the architect, interior designer, and lighting designer. Even the people using the space have a role since what they put in the space can also ruin a good daylighting effort. High cubicles or walls with dark tapestries can absorb too much light leading to uncomfortable contrasts. You
can try to change people’s behavior by showing them a light meter that reads 35-foot candles or higher indicating they don’t need to switch the lights on, but this approach is no more effective than telling someone they are comfortable and shouldn’t change the thermostat setting simply because the thermostat is reading 72°F. Comfort is subjective, not a numbers game.

But, when daylighting does work, it is spectacular as well as an energy saver. To that end, I strongly recommend that anyone who wants to see successful daylighting in the Midwest visit the following spaces on a sunny day:

- Architecture Studio at Judson University, Elgin, Illinois
- Energy Center of Wisconsin Conference Room, Madison, Wisconsin

A picture of a successfully day-lit classroom in the Mountain states appears below:

![Successfully daylit classroom with electric lights off. (Photo credit: E. Truelove)](image)

The lights in this classroom are off, but would you have noticed if you walked into this room? You have to look at the suspended light fixtures to see they are off. Your eyes are tricked into believing the lights are on which is exactly the situation we want. The architect used modest amounts of glass, not curtain-wall, combined with a white finished ceiling, light tubes, off-white floor, and light wood cabinets that bounce the indirect sunlight around the room, eliminating contrasts and making our eyes comfortable with what they see.

So what is the difference between daylighting that works and daylighting that disappoints? After seeing numerous examples of both, I believe it boils-down to a list of design attributes that seem to repeat for all of the success stories. My colleagues frequently criticize me for presenting formulae or recipes since each building is unique. I agree that each building, like each person, is unique. But, I also believe that common elements work for almost all buildings just like the advice “eat right and exercise regularly” works for almost all people. Here are my recommendations on how to design a successful day-lit building:

1. Keep the window-to-wall ratio between 25 percent and 35 percent.
2. Go with an ideal finished ceiling height of 9-feet.
3. Specify glass with a visible light transmittance between 0.40 and 0.60.
4. Put exterior overhangs on the southern exposure or recess the windows. These overhangs or recess should equal about one-third of the window assembly height.

5. Use skylights or light-tubes in spaces more than 20-feet from an exterior window, but make sure the skylight/light tube area is no more than 5 percent of the total roof area.

6. Specify a finished ceiling that is white. Don’t use an open ceiling.

7. Specify wall and finished floor colors with a minimum reflectivity of 0.8.

8. Mount light fixtures parallel to the nearest exterior wall. Up/down suspended fixtures are ideal.

9. Don’t value-engineer the lighting controls. If you don’t have daylighting controls on your fixtures, you don’t have daylighting.

Successful daylighting is achieved when occupants’ eyes find the light to be comfortable, not just having the light levels fall within some range of numbers as measured by a light meter. The vast majority of people who work indoors prefer a building that acts like the canopy of a full growth forest, letting indirect light penetrate to the ground, but eliminating any glare or contrast that leads to eye discomfort. Try this for yourself: take a book or a portable computer into a full growth forest on a sunny, mild day and either read the book or work on the computer for a few hours. You won’t need to bring a light along, just a comfortable chair and a good cup of coffee. That’s daylighting at its best!

Eric Truelove can be reached at 608-332-8444 or etruelove@att.blackberry.net.