

# SHINING LIGHT ON DAYLIGHTING WITH METAL ROOFS

Good rates of return for using integrated daylighting systems with novel prismatic optics, along with high-efficiency lighting, in metal envelope systems with good thermal and barrier performance.

By C.C. Sullivan



**M**etal roofing and wall systems of insulated metal panels, or IMPs, have been shown to provide exceptionally durable, energy-efficient and sustainable enclosures. The systems typically have a thick layer of polyisocyanurate insulation protected by metal sheathing on one or both sides, creating an effective air and moisture barrier with good thermal resistance. Recent studies and field evidence, however, have shown that coupling these opaque roof and envelope systems with integrated daylighting and electrical lighting systems -- in particular, with skylights, windows and translucent panels -- contribute to enhanced occupant experience and improved overall building performance.

As recently as a decade ago, applications of skylights and other daylighting products were considered costly and required extensive detailing and coordination among various building trades. Early skylight designs often also displayed poor U-factor. In the last few years, however, skylight assemblies are significantly improved, with more effective seals and thermal breaks as well as better thermal performance.

Today in the nonresidential building industry, a range of novel daylighting products and technologies have been introduced in recent years that facilitate the uncomplicated and proper deployment of natural illumination for a range of occupancies. These include pre-engineered, integrated metal envelope and roof solutions with compatible curbless skylights, light tubes, pan-type prismatic skylights, automated dimming controls for lighting, motorized shades, and other components.

These systems also take advantage of new tools to maximize daylighting effectiveness while also maintain the envelope's barrier and thermal performance. For example, the effectiveness of conventional flat skylights has been eclipsed by the newer domed and pan-type units with *prismatic embossing*, which refracts and directs two to four times as much illumination into the indoor spaces when *solar incidence angles* are more acute, such as in the early morning and late in the day. These prismatic elements also help eliminate "hot spots" and reduce glare and ultraviolet (UV) deterioration from daylighting.

The increasing focus on roofing systems, skylights and *toplighting* among many building teams and occupants reflects the ample contribution of roof-installed devices for daylighting. Several studies confirm that toplighting with skylights and electronic lighting controls (to dim and turn off electric lights) can reduce annual lighting energy loads by 35% to 55%. One confirming report by the U.S. Department of Energy<sup>1</sup> (DOE) showed that the same daylighting methods can save building owners \$0.11 to \$0.32 per square foot on utility costs, depending on climate, building type and power rates.

There are other benefits to the new integrated daylighting systems for metal roofing systems. First, the higher transmittance of the prismatic skylights means that for an equivalent design, building teams can reduce the total number of required roof penetrations. Second, some units are designed for integration into the seams or joints of the metal roof and wall panels, reducing exposure to mass water flow. Third, novel skylight designs have self-curbing or non-curb installation. This feature obviates a longstanding challenge of traditional skylights, which have significant risk of water leaks at flashed curbs. Fourth and most important, next-generation skylights with integrated lighting controls using photosensing dimmers can reduce associated electricity costs by up to 70%, offering a documented return on investment (ROI) with payback periods as short as 36 to 60 months.

### With Strategic Partnerships, Metal and Daylighting Earn Wider Market

The recent introduction of "strategic partnerships" among allied manufacturers of metal roofing and wall panels with makers of skylights and lighting products has led to the increased availability of integrated daylighting systems with metal enclosures. The primary benefits are assured compatibility of the product suites and componentry, as well as increased speed of construction, in some cases.

Called total envelope solutions in some literature, the engineered systems now encompass curbless "light tube" skylights for IMP and 42-inch wide standing seam roof panels, as well as pan-type, flat panel prismatic skylights curb-mounted on standing seam roofs with integral thermal breaks and condensation channels.

Other products being packaged with metal envelope systems include "light-pipe" style tubular skylights with reflective surfaces or optical fibers, LED luminaires and dimmable lighting controls, as well as interior wall liner panels with light-colored, high-reflectance finishes.

Many of these integral envelope systems and strategies have passed the tests and standards required by building codes. They have been shown to ease integration, as with the non-curb roof penetrations, and simplify construction. Once installed, they save energy and offer all the social benefits of natural sunlight. In sum, engineered envelope systems or total envelope solutions also come with compelling rationales for their use.

<sup>1</sup> TIAX LLC, for U.S. Department of Energy. Commercial Building Toplighting: Energy Saving Potential and Potential Paths Forward, [http://apps1.eere.energy.gov/buildings/publications/pdfs/commercial\\_initiative/toplighting\\_final\\_report.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/toplighting_final_report.pdf).

<sup>2</sup> [http://h-m-g.com/projects/daylighting/summaries%20on%20daylighting.htm#Skylighting\\_and\\_Retail\\_Sales%20-%20PG&E%201999](http://h-m-g.com/projects/daylighting/summaries%20on%20daylighting.htm#Skylighting_and_Retail_Sales%20-%20PG&E%201999)

**CASE STUDY:** Adoption of these novel daylighting technologies is robust in the high-tech manufacturing market. One Northern California-based maker of computers, tablets and phones recently adopted a “comprehensive lighting solution including 650 high-bay LED lighting fixtures and about 1,150 solar light pipes integrated with a user-friendly, energy-saving control system” for a distribution facility. Provider Orion calculated the annual energy savings at \$17,724 for 207,305 kWh of displaced energy, the equivalent to eliminating 135 tons of CO<sub>2</sub> annually.

## SUSTAINABILITY AND SOCIAL BENEFITS

Clearly, the life-cycle analysis (LCA) of a manufacturer-integrated system of insulated metal roofing and skylighting goes well beyond a simple dollar-for-dollar comparison of building operations. New research presents evidence of the global payback -- reduced greenhouse-gas emissions and carbon footprint, for example -- as well as valuable social benefits such as improved perceived quality of the indoor environment (IEQ) and enhanced health and wellness. Daylighting has also been shown to increase productivity in business settings, boost student performance in schools, and even enhance patient recovery in hospitals.

While these are often called “soft benefits” because they are harder to quantify than utility savings, these advantages offer perhaps the most significant case for using daylighting. For example, in a seminal study by Hescong Mahone Group<sup>2</sup>, “The potential contributions of windows and daylight to improved performance by office workers” included better scores on cognitive assessment tests and improved work performance by call center workers and general office workers, in some cases boosting output by 6% to 12%.

The group also looked at elementary schools with and without daylight as an illumination source, analyzing test scores for 21,000 students in California, Colorado and Washington. Representative results in one district showed how “students with the most daylighting ... progressed 20% faster on math tests and 26% on reading tests in one year than those with the least.” For retail settings, Heshong Mahone showed in 1999 that “skylights were found to be positively and significantly correlated to higher sales,” and that non-skylit stores are likely to have 31% to 49% higher sales if skylights are installed. This explains why retail chains like Costco and Wal-Mart stores are among the largest end-users of curbed skylights.

In terms of health and wellness, again daylighting tends to outperform electrical lighting dramatically. In addition to better long-term outcomes in work settings, the average length of



Orion light tubes bring in a comparable amount of light as a standard fixture, even on a cloudy day. (The pipes are the two sources of light nearest the center of the photograph.)

hospitalizations actually decreases by as much as 16% to 41% in highly daylit rooms.<sup>3</sup> As part of a new certification program, the WELL Building Standard, daylight is required to “minimize disruption to the body’s circadian rhythm ... and to improve energy, mood and productivity” of the building occupants.

With greater utility and enjoyment alongside improved life-cycle performance and reduced operating costs, buildings with daylighting are becoming more desirable. Using metal roofs and IMP wall systems provide high thermal performance for the base enclosure system, and the availability of integrated daylighting products engineered to be compatible with metal panel exteriors further increases their attractiveness. Yet to avail of these advantages and optimize results, building professionals must consider a variety of best practices for metal building daylighting.

## GENERAL PRINCIPLES FOR METAL ENCLOSURE DAYLIGHTING

The goals of daylighting with metal roofs include advancing sustainability principles while reducing carbon footprint. Occupant wellness and enjoyment -- along with improved occupant productivity or output -- have been correlated with increased daylighting and skylight use.

**DAYLIGHT HARVESTING.** Also called daylight dimming, this concept requires a systems approach including metal wall panels, fenestration, electrical lighting and dimmable con-

<sup>3</sup> Choi, J.H.; Beltran, L.O.; Kim, H.S. Impacts of indoor daylight environments on patient average length of stay (ALOS) in a healthcare facility. *Build. Environ.* 2012, 50, 65–75. (From *Buildings* 2015, buildings, ISSN 2075-5309, [www.mdpi.com/journal/buildings/](http://www.mdpi.com/journal/buildings/))





Orion Energy Systems' plant in Manitowoc, WI uses both light pipes and roof-top PV to lower their energy use. These photos were taken within minutes of the inside photograph, showing the sky conditions at the time.

trols. To enhance the systems, occupancy sensors and other dynamic control devices may be used with ambient lighting fixtures that are automatically dimmed based on available solar illumination. According to Orion, a manufacturer of these systems, wireless controls provide an effective retrofit for existing or new high-intensity fluorescent and LED lighting platforms. The systems include both transient and sustained motion control, lighting zone controls, and integration with daylighting products such as solar light pipes. Additional system enhancements include programmable time-of-day scheduling and power monitoring of electrical equipment, accessed via cloud-based data storage and an end-user dashboard.

**CASE STUDY:** Examples of daylight harvesting in action are everywhere, including at a manufacturing and distribution facility in Brownwood, Tx., operated by Kohler Co. The system combines solar light pipes with dimmable fluorescent high-bay fixtures and motion control sensors. The approach saves more than \$262,000 annually in electricity costs and cuts CO<sub>2</sub> emissions by 1,880 tons, and employees have noted the more appealing quality of natural sunlight.

**ADVANCED APERTURE DESIGNS.** In addition to facilitating daylight harvesting, today's pre-engineered skylight products for metal and other roofs feature improved optics, glare control and high-durability housings. Building teams should review toplighting devices designed specifically for institutional or commercial and industrial applications, with translucent domes or panels made of acrylic or polycarbonate. Leading designs include seamless, all-aluminum construction with built-in roof flashing as well as closed-cell insulation between the roof flashing and reflector surfaces. To boost useful



daylight indoors, many products have prismatic refractors and single or double interior diffusers (with or without UV blocking) to maximize illumination yield.

**VERTICAL FENESTRATION.** Toplighting is the most effective method for daylighting, yet in many building designs it can and should be supplemented by clerestory, view windows, translucent wall panels and other vertical daylighting devices. Building orientation, façade and roof configuration and programmatic elements are the building perimeters will influence which vertical fenestration approaches are used. To protect against unwanted glare and excessive solar heating, vertical openings may be treated with sun control and shading elements including overhangs, sunshades, vertical fins or light shelves, as well as interior shades and louvers. These elements generally supplement the use of high-performance glazings, such as low-E glass, with high visible light transmittance (VT), as well as techniques such as tree plantings for seasonal shade.

In addition, the use of insulated translucent wall panels can provide an effective daylight source with high thermal values. For calculations of their daylight contributions, the VT and haze factor must be known for the panels. However, most building codes fail to include a U-factor baseline from which to compare the baseline performance of wall translucent panels (often called *wall lights* in the industry), so they are often erroneously calculated as if they were windows.

**DAYLIGHTING DESIGN TOOLS.** With so many potential variables in daylighting, resolving the optimal design scheme can be a relatively complex task. To assist, a number of aids are available on the market to help architects and engineers

calculate and visualize the results of proposed project schemes. These include general energy modeling tools like EnergyPlus and skylighting-specific products like SkyCalc. "Since the efficacy of a daylighting design is tightly tied to the building design, the best way to assess a daylighting project is to perform a daylighting analysis through simulation," according to Gregg D. Ander, FAIA, of Southern California Edison<sup>4</sup>. Typical output includes daylight illuminance levels, from daylight, expected dimming and switching response, annual energy savings and even glare probability, Ander explains.

## KEY VARIABLES AND COMPONENTS FOR DAYLIGHTING

Working under these basic principles and premises, building teams will encounter a number of key variables that help measure the effectiveness of proposed daylighting designs. The most common (and valuable) daylighting performance metrics in use today include the following:

- » **Daylight factor.** This compares available outdoor brightness to indoor lighting needs. As an example, an overcast sky provides considerable illumination through skylights and windows, with an average illuminance of 1,000 footcandles. (A footcandle, often given as fc, is equivalent to the illumination from one candle at a distance of one foot, and the same as one lumen per square foot.) For desktop or assembly-line work, a person typically only needs 20 footcandles -- or a daylight factor of about 2%.

<sup>4</sup> <http://www.wbdg.org/resources/daylighting.php>

- » Window-to-wall ratio, or **WWR**. If the building is relatively open or has high windows such as clerestory, even low values of WWR can provide effective daylighting.
- » Effective aperture, or **EA**. Per ASHRAE, this is the overall amount of visible transmittance of the roof via skylights. It is equal to 0.85 times the skylight area times the skylight VT times a *well factor* (WF) and then divided by the daylight area under the skylight. (Well factor, sometimes called well efficiency, is 0.9 for light well depths under 2 feet and 0.7 if greater than 2 feet.) In this way, EA compares available illumination and window size or skylight size. EA shows that south-facing and larger windows, generally, can have darker glazing, while smaller windows and skylights can be clearer.
- » **Daylighting depth**. Skylights offer full daylighting depth, illuminating areas within the floorplate wherever they are placed. Typical perimeter windows can daylight to a depth of about 1.5 times the window head height. Adding a light shelf can improve the depth to about 2.0 times the window head height.
- » Solar heat-gain coefficient, or **SHGC**. Lower values of SHGC mean less solar radiation enters through the aperture to heat the interior. While windows offer outdoor views, they tend to require control measures to limit or exploit heat gain. Translucent materials and novel skylight designs with acrylic and polycarbonate glazings, on the other hand, admit light with little SHGC.
- » **Haze factor**. For specifying skylights, it is important to know how much light entering through the glazing material is *diffused*. Expressed as a percentage, this is the haze factor. According to the American Architectural Manufacturer's Association (AAMA), codes require skylights to have a minimum 90% haze factor.
- » **U-factor**. While R-value, the thermal resistance of a material, is important to design calculations, more important is U-factor or U-value, which gives the overall heat-transfer coefficient of a building element such as a skylight or window. Lower is better, meaning the product is more resistant to heat flow and a better insulator. In general, the U-factors of daylighting elements like windows and skylights are, by definition and by design, higher (or worse) than opaque walls or roof areas. "Still, the idea is that the total energy efficiency of the entire building goes up," says Bob Zabcik, director of R&D for NCI Building Systems.

Using the above tools and terminology, building teams can better assess the benefits of daylighting strategies with skylights, prismatic pan-type products and solar light pipes, among others. In particular, these are important for meeting the widely used 2012 International Energy Conservation Codes (IECC) and ASHRAE 90.1, as well as state energy codes and "reach targets" such as green building certifications, the Passive House standard, and others.

In general, code compliance and optional certifications are determined using either prescriptive or performance-based paths. Using the performance path affords the most flexibility for using skylights as part of an energy-efficient daylighting strategy that meets the stringent 2012 IECC requirements. It is essential to employ energy modeling during the design process in order to verify compliance to the codes for the performance paths. In some cases, an independent third-party must conduct the modeling, using software such as Rem/Design or EnergyGauge, according to Building Performance Group of Louisville, Ky. "These tools model building performance based on the building plans and specs," says the company, "and the software will state whether or not the plan will pass the new code requirements."

In general, using today's novel skylight products in combination with a highly thermally efficient base system of metal panel walls and roofing will both reduce excessive solar heat gain as they reduce the electrical base load for lighting. Highly diffusing acrylic and polycarbonate lenses and spectrally selective glass openings are exceptionally effective for maximizing functional visible light indoors while inhibiting unwanted heat gain. Many of the skylight aperture designs block 85% of infrared (IR) and 99.9% of UV light, which also reduces the unwanted degradation of products and materials inside the buildings. Yet the new generation of skylights also optimizes solar harvesting because many of the lenses have a minimal effect on VT.

In this way, the use of skylights with metal roofing and IMPs can be an effective way to meet the requirements of IECC 2012 and state energy codes including California's Title 24 and "stretch code" minimums set forth in Massachusetts, Minnesota, Wisconsin and other states. The skylights reduce overall electrical loads without adding unacceptable levels of solar heat gain, and their small relative area means the overall roof U-values remain low. In addition, daylighting fixtures offset the wattage used by ballasts, which may add 25% to the load for electrical lighting. The ballasts also add heat to the occupied space or, if recessed, into the ceiling plenum.

Not incidentally, the latest generation of skylight systems offers good levels of fire resistance and acoustical sound transmission, and they are highly durable and resilient to the elements.



In sum, the total energy efficiency of the entire building goes up by using properly designed, specified and installed skylights with integrated lighting systems, with total savings ranging from 2% to a high of 5%. For guidance on the proper application of skylights, ASHRAE Standard 90.1 offers guidance on WWRs and other variables based on climate zone, mainly to ensure ideal or acceptable recommended levels of thermal performance. To determine the economic basis for using skylights, building teams use a simple ROI calculation or a more detailed life-cycle cost. Generally by accounting for the high thermal performance of the skylight systems, along with the high efficiency of the LED lighting fixtures (up to and exceeding 179 lumens per watt), the tipping point is achieved without even considering the “soft benefits” of decreased absenteeism or increased productivity and output. In general, it is seen as a “very big impact on rate of return and costs,” says one facility manager.

**CASE STUDY:** At Fort Bliss in El Paso, Tx., the U.S. Army's second largest base in the United States, operations leaders considered replacing inefficient metal halide lamps with natural daylight. A simple energy modeling analysis suggested significant annual savings. Using more than 1,000 solar light pipes in eight of the base's facilities, the roof-mounted systems harvest sunlight and focus it into each building's interior cavity. The retrofit project decreased annual energy consumption by 725,400 kWh, saving an estimated \$63,500 in electricity costs per year.

## SYSTEMS APPROACH: METAL ENVELOPES AND DAYLIGHTING

More than anything, the use of building systems combining metal roofing with skylights and integrated lighting provide significant life-cycle performance. Much of this is due to the research and development behind the individual products and materials used for these applications.

Begin with metal buildings, roofing and wall panels: These products are made with recycled steel and other metals, which according to MBCI may comprise 30% to 60% of the steel used in manufacture. The resulting steel products “are virtually 100% recyclable,” adds the company, “helping to conserve natural resources and reduce environmental damage.” The envelope panels are very durable, resisting fire, wind and pest damage and generally lasting longer than many other building products, with minimal maintenance and with less replacement required. These attributes reduce waste, labor costs and adverse environmental effects.<sup>5</sup> In addition, a number of recently developed products, such as the pre-engineered, integrated



Before and after images of daylighting within the Bay Insulation Systems facility in San Marcos, Texas. The facility went from 29 to 123 foot candles on the floor.

daylighting systems, have been developed specifically to increase energy efficiency and reduce harmful environmental effects.

In addition, fabricating metal wall panels and roofing products in a factory environment makes it easier to manage the environmental effects of processes like cutting, painting, slitting and forming. Depending on the application, metal enclosures can provide advantages in project scheduling and speed of construction. Many of the metal enclosure systems are coupled with integrated window systems that ensure continuity of thermal and moisture barriers while reducing thermal

<sup>5</sup> <http://www.wbdg.org/resources/daylighting.php>

bridging and other negative effects. Metal roofing has been shown to be compatible with roof-mounted solar photovoltaic arrays, which may cause failures on other roofing types such as single-ply membranes and built-up asphaltic. For residential-type construction, common roofing types such as asphalt and composition shingles are among “the worst options for solar panel installation,” according to Proud Green Home.<sup>6</sup>

Last, the use of integral daylighting systems is an increasingly common feature for metal-clad structures. Among the primary product types developed for these engineered applications are:

## SOLAR LIGHT PIPES

Among the newest in this class of toplighting products is the Apollo® Solar Light Pipe LP, created Orion Energy Systems. Compared to curb-mounted skylight units, these products require only a basic roof cut with no curbs, which eliminates some flashings and coordination among trades typical of traditional skylight construction, which may fail or allow in water. Unlike other, larger skylight types, solar light pipes generally meet security and life-safety needs without adding burglar bars or safety grids.

Typically the dome is made of acrylic or polycarbonate: new materials, no longer fiberglass (less yellowing). The dome lens design and the reflective and optical internal materials increase the total surface area and provide more refraction area from the lens. This improves the EA (effective aperture) while also addressing heat-loss issues typical of some skylight designs.

CASE STUDY: For a warehouse in Natick, Mass., the owner Natick Soldier Systems Center installed an array of solar light pipe products to address both a desire for interior daylighting as well as reduce energy costs. According to the environmental engineer Rich Valcourt, even on cloudy days early in the morning, the light pipe arrays draw enough light into the warehouse for light meter readings of about 12 footcandles. This is much better than the minimum 5 footcandles recommended or required by some codes for minimum illumination within a warehouse work setting. In addition, the facility’s mercury vapor lamps see little use during the day, year ‘round.

## LIGHT TRANSMITTING PANELS, STRIP LIGHTS AND CURB LIGHTS

Several other simple yet novel techniques are used to save costs through daylighting with metal roofing. As more architects become familiar with these new product types, jurisdictions throughout the United States are seeing more use of them. Examples include the Nucor CFR™ Integrated Prismatic

Skylights, which appear as a ridged array of double-glazed polycarbonate lenses mounted to a trapezoidal steel panel that is seamed with the rest of the metal roof. Shipped as a ready-to-install unit, the prismatic skylights allow 100% diffusion and transmit 35% more light than conventional skylights, eliminating hot spots and glare. A 2-foot by 10-foot panel is rated at an SHGC of 0.42, visible light transmission of 0.64, and a U-factor of 0.74.

Similar products include Bay Industries’ Baylight™ Prismatic Skylight, a domed skylight with a very high visible light transmittance and an effective, diffuse light distribution pattern.

CASE STUDY: The company Lefever Building Systems installed skylights in its highly insulated metal buildings which span about 30 feet. Single prismatic skylights centered on the roof span and spaced about 50 feet provide enough interior illumination to obviate the need for electrical lighting. “They are worth the money,” says Scott Yarmer, the company’s Rocky Mountain sales manager, explaining that in some cases no electrical lights or power are needed for these rural building projects.

## INTEGRATED DAYLIGHTING AND DIMMING WITH CONTROLS

New lighting types including high-bay LEDs and strip lights are being integrated with skylight systems and daylighting controls for both dimming and occupancy sensing. These are coupled with metal roofing and metal wall panel systems to create more energy-efficient facilities with low operational costs.

CASE STUDY: This was the strategy for Miller Brewing Co.’s production facility in Milwaukee. According to Orion, “Miller’s business strategy calls for continually seeking cost-effective improvements in operations that result in more efficiency in the use of energy.” Miller implemented Orion’s integrated energy-management platform in a pilot upgrade project for the brewery, combining Orion’s patented Compact Modular™ HIF fixtures with wireless Intelite® controls and renewable Apollo™ Light Pipes. The test project for the Milwaukee facility was successful, encouraging the company to implement the same integrated scheme in its Phase I across all major breweries across North America.

“The new fixtures provide better light, are more efficient and help reduce Miller’s energy consumption,” according to Miller’s Sustainable Development Report written at the time. “New motion sensors automatically conserve energy when the lights are not needed and the integrated light pipes determine and regulate the amount of light needed, if at all, during daylight hours.” Annual savings for the pilot project amounted to \$595,000 for the total displaced energy of about 9 million kWh. This meant annual CO2 reductions of 6,134 tons along

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<sup>6</sup> <http://www.proudgreenhome.com/news/choose-a-metal-roof-for-your-residential-solar-panel-mounting-system-2/>



with 24 tons of SO<sub>2</sub> and 9 tons of NO<sub>x</sub>. Mercury use was also reduced by about 0.242 lbs. Before the upgrades, the brewery averaged about 465 watts per fixture, and after Orion Phase I, the company now uses only 220 watts per fixture.

## NOVEL INSULATION TECHNIQUES AND INTERIOR FINISHES

In addition, the use of light-colored and white reflective interior finishes is a design strategy used to enhance the use of daylighting systems and electrical lighting. Some new products, such as Bay Industries' Skyliner™ Insulation Systems, make metal buildings more energy efficient and brighter because they include a highly reflective, white finish surface that is continuous across the interior space. The product is shown to meet all testing as required in energy standards and codes, and it provides high-performance in both retrofit applications and new construction. The applicable measures include very low U-factors and the ability to reduce heating and air conditioning loads.

**CASE STUDY:** Recent projects taking advantage of Skyliner's white reflective surfaces to make building interiors brighter and aesthetically pleasing include the facilities for Ranex, constructed by the builder Area Steel in South Dakota, as well as a large shop structure for Riley Construction in Kansas. Most important, the illumination of the interiors improved significantly, giving them greater lighting efficiency levels.

## CONCLUSION

As these novel products and project applications demonstrate, the new strategic partnerships among allied manufacturers of metal roofing and wall panels with makers of skylights, lighting products controls and even insulation has boosted the use and effectiveness of daylighting metal enclosures. The systems deliver compatible, integrated products and materials, and they enhance the durable, energy-efficient and sustainable enclosures built with metal roofing and IMPs.

Recent studies and field evidence also underscore the environmental and wellness benefits of coupling opaque metal roof and envelope systems with enhanced daylighting. Case studies and industry research show how skylights, windows and translucent panels contribute to enhanced occupant experience and improved overall building value.

In addition, these recently introduced product suites provide for efficient, cost-effective approaches to daylighting. In this way, an approach that has long been considered costly and difficult to coordinate is now available as a high-value, low-impact standardized construction technology. These pre-engineered, integrated metal envelope and roof solutions deliver such daylighting methods as compatible curbless skylights, light tubes, pan-type prismatic skylights, automated dimming

controls for lighting, motorized shades, and other components including white insulated interior surfaces.

These systems also take advantage of new tools to maximize daylighting effectiveness while also maintaining the envelope's barrier and thermal performance.

Several studies confirm that toplighting with skylights and dimmable lighting controls can cut energy loads by 35% to 55%, saving building owners up to \$0.32 per square foot in costs. With next-generation skylights and integrated lighting controls, a documented ROI is achievable for many building teams, delivering payback in as little as 36 to 60 months.

## CONTACT

For more information about MBCI and its family of companies and many product offerings, visit [www.mbc.com](http://www.mbc.com) or call (877) 713-6224.

## SOURCE LIST

- NCI (Bob Zabcik, Director of R&D)
- U.S. Department of Energy
- Proud Green Home
- U.S. Green Building Council
- Whole Building Design Guide
- National Institute of Building Sciences
- Building Enclosure Council, National
- TIAX LLC
- EERE, U.S. DOE
- Healthy Buildings Initiative
- Buildings 2015
- MBCI
- Bay Insulation Systems (Mike McLain, Carl Lewis, Tim Kessel and Tim Pendley)
- Orion Energy Systems (Pat Lazure, Tom Teteak and Mike Potts)

